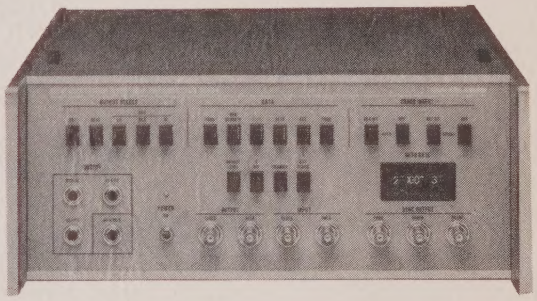
MAINTENANCE MANUAL

Model 4653A
Error Rate Transmitter



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Scientific Atlanta

Model 4653A
Error Rate Transmitter

Maintenance Manual

First Edition

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INSTRUMENTATION

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OVERVIEW

0.1 INTRODUCTION

The Scientific-Atlanta Model 4653A DS1/1C/2 Error Rate Transmitter is supplied with two manuals: the Operator's and the Maintenance. This Maintenance manual provides technical information such as theory of operation, service maintenance procedures, parts listings, printed circuit board layouts and schematics, and is designed to be used in conjunction with the Operator's manual. However, some of the more frequently referred to information (from the Operator's manual) is reprinted in this Overview section in case the Operator's manual is not readily available.

NOTE

Maintenance or service of this equipment must be performed only by trained service personnel who are aware of the hazards involved, such as fire and electrical shock.

Although this unit is very similar to the Model 4653 Error Rate Transmitter, there are several differences. Please be sure you have the correct manual for your unit.

0.2 TECHNICAL SPECIFICATIONS

INTERNAL CLOCK Frequency	1.544 Mbps, 3.152 Mbps, 6.312 Mbps (DS1/1C/2) crystal sources
Stability	±15 ppm, 0° to 50°C

EXTERNAL CLOCK INPUT	
Connector	BNC
Frequency	1 MHz to 10 MHz
Impedance	75Ω, ac coupled
Amplitude	1-5V peak-to-peak
CLOCK OUTPUT	
Connector	BNC
Impedance	75Ω
Amplitude	TTL, 0-3V
DATA FORMATS (See Note page 0-4)[1]	
Pseudo Random Bit Sequence (PRBS)	1,048,575 bit sequence, 15 or 14 zero suppression (see Section 3.4-B), with all control bits. DS2 output uses B6ZS coding for framed or unframed, DS1C uses modulo-2 scrambling for framed only.
Minimum Density	If the DS1 signal is framed, MIN DENSITY is 2 ones and 14 zeros, and if unframed, it is a single one and 15 zeros.
All Ones Data	Continuous data sequence of ...111... with control bits
One-Zero Alternate	Alternating sequence of 1010 with control bits
External Data	TTL level input from receiver using external clock
Programmed	8-bit pattern, user selected by internal DIP switch
ERROR INSERT	Single bit or bipolar violation insert. Bit or bipolar violations from 9×10^{-3} to 1×10^{-9}. Mantissa and exponent adjustable in single steps by thumbwheel switch.
X-BIT	Forces X-bits from 1 to 0
BIPOLAR DATA OUTPUTS	
DS1	
Impedance	Balanced, 110Ω
Level	3V ± 0.3V peak with 0.15V peak imbalance maximum
Width	324 ± 30 ns half amplitude with 15 ns imbalance maximum

Rise/Fall Times	50 ns ± 25 ns, 10% to 90%
Over/Under Shoot	Less than 10%
Balance	Positive pulse/negative pulse power ratio ±0.5 dB
Connector	Accepts WE 310 plug
DS1C	
Level	3V ±0.3V peak
Width	159 ±20 ns at half amplitude
Rise/Fall Times	25-50 ns, 20% to 80%
Over/Under Shoot	Less than 10%
Baseline Noise During a Zero	Peak-to-peak noise less than 10% of peak signal
Balance	Positive pulse/negative pulse power ratio <±0.5 dB
Connector	Accepts WE 310 plug
DS2	
Level	HI: 2.1V peak ± 1dB DSX: Simulates HI pulse passed through 1000 ± 100 feet of 22 gauge ABAM cable LOW: Simulates DSX pulse passed through additional 1000 ± 100 feet of 22 gauge ABAM cable and attenuated by additional 6 dB
Connector	Accepts WE 310 plug
SYNC OUTPUTS	PRBS, ERROR, FRAME. 50Ω, TTL. See Table 3-1.
REDUCE LEVEL	DS1: -24 dB DS1C: -24 dB DS2: -40 dB
GENERAL	
Power Supply	115/220V ac ± 10%, 50-60 Hz linear supply, or optional 115/220V ac -22 to -60V dc, positive ground (station battery) switching supply. 50 watts
Weight	20 lbs.

Dimensions	13"W x 15"D x 5.25"H
Temperature	Operating: 0° to 50°C Storage: -20° to 50°C

NOTE: [1] Formats refer to the DS1 Signal or to Unframed DS1C/DS2. For framed DS1C/DS2, 2 or 4 DS1 channels are multiplexed with all overhead bits including stuffing. Channel 1 is inverted and delayed one bit successively to form other channels.

0.3 FRONT AND REAR PANEL CONFIGURATION

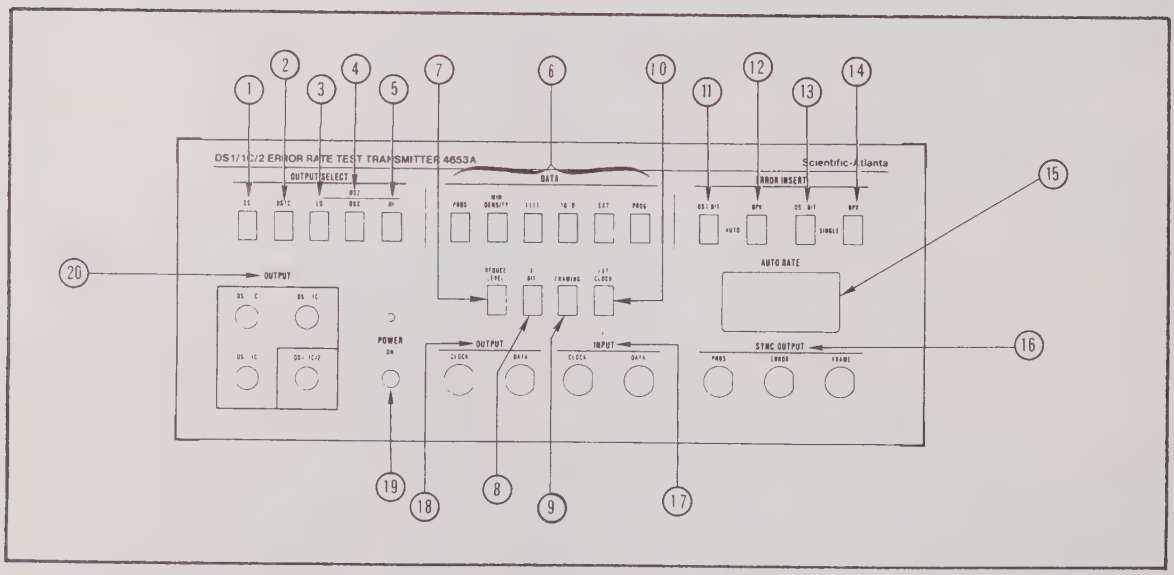


Figure 0.1. Front Panel Controls and Indicators

Reference Symbol	Panel Decal
1	Output Select DS1
2	Output Select DS1C
3	Output Select DS2-LO
4	Output Select DS2-DSX
5	Output Select DS2-H1

Reference Symbol	Panel Decal
6	Data - Type Select Switches
7	Reduce Level
8	X-Bit
9	Framing
10	Ext Clock
11	Error Insert - DS1 Bit-Auto
12	Error Insert - BPV-Auto
13	Error Insert - DS1 Bit-Single
14	Error Insert - BPV-Single
15	Auto Rate - Thumbwheel Switches
16	Sync Output
17	Input Connectors
18	Output Connectors
19	Power On Switch and Indicator
20	Output Connectors

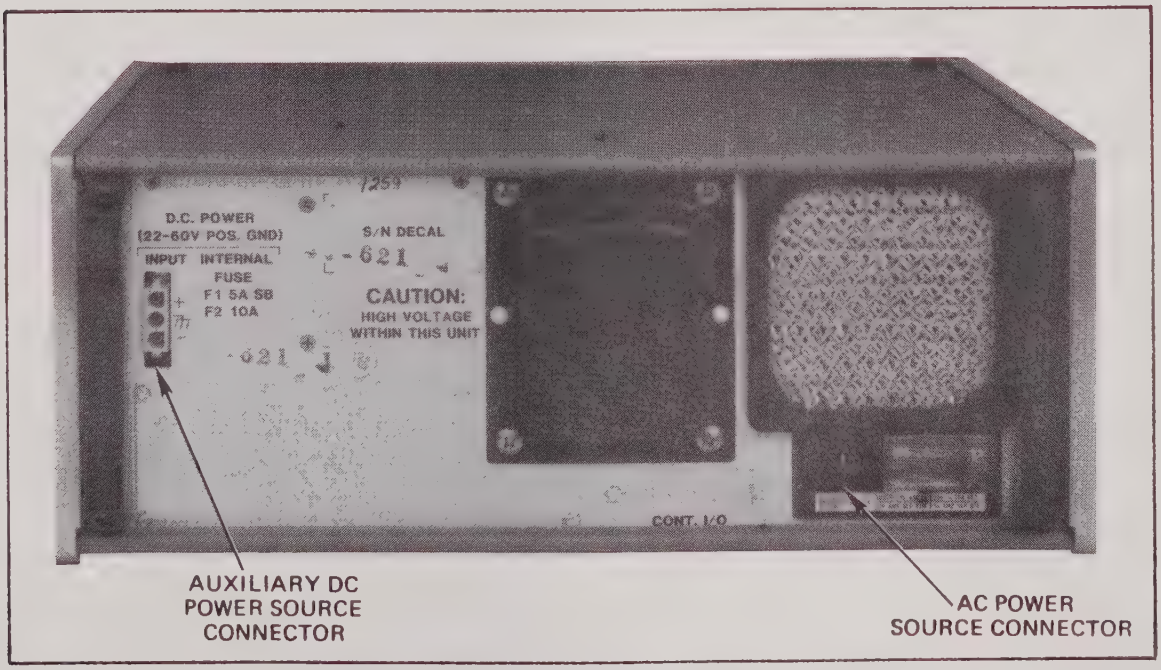


Figure 0.2. Rear Panel Connectors

CHAPTER 4
THEORY OF OPERATION

4.1 GENERAL

Theory of operation for the Model 4653A DS1/1C/2 Error Rate Transmitter is presented in two parts. Part One describes the power supply while Part Two describes features and functions. The power supply is described in a separate section because the dc supply used in this system operates independently from other circuits. The transmitter may be ordered with an ac/dc switching supply or an ac-only linear supply. Both are described in this section.

The Model 4653A Transmitter generates DS1, DS1C, or DS2 formatted digital signals in either a bipolar arrangement or a non-return to zero (NRZ) arrangement with separate clock and data lines. Figure 4.1 outlines key features of the DS1 signal format. Figure 4.2 outlines key features of the DS1C signal format. Figure 4.3 outlines key functions of DS2 signal format. The Model 4653A Transmitter can output a 1,048,575 bit long pseudo-random sequence, a minimum density signal consisting of a "one" followed by 15 zeros or 2 ones followed by 14 zeros, an "all ones," "alternate ones and zeros," an external data signal, or a programmable 8-bit sequence for information bits.

4.2 MODEL 4653A POWER SUPPLIES

The Model 4653A Transmitter is available with: (1) one ac-only linear supply, or (2) an ac/dc switching supply.

The ac-only supply will operate on a 115V/220V, 50/60 Hz ac line.

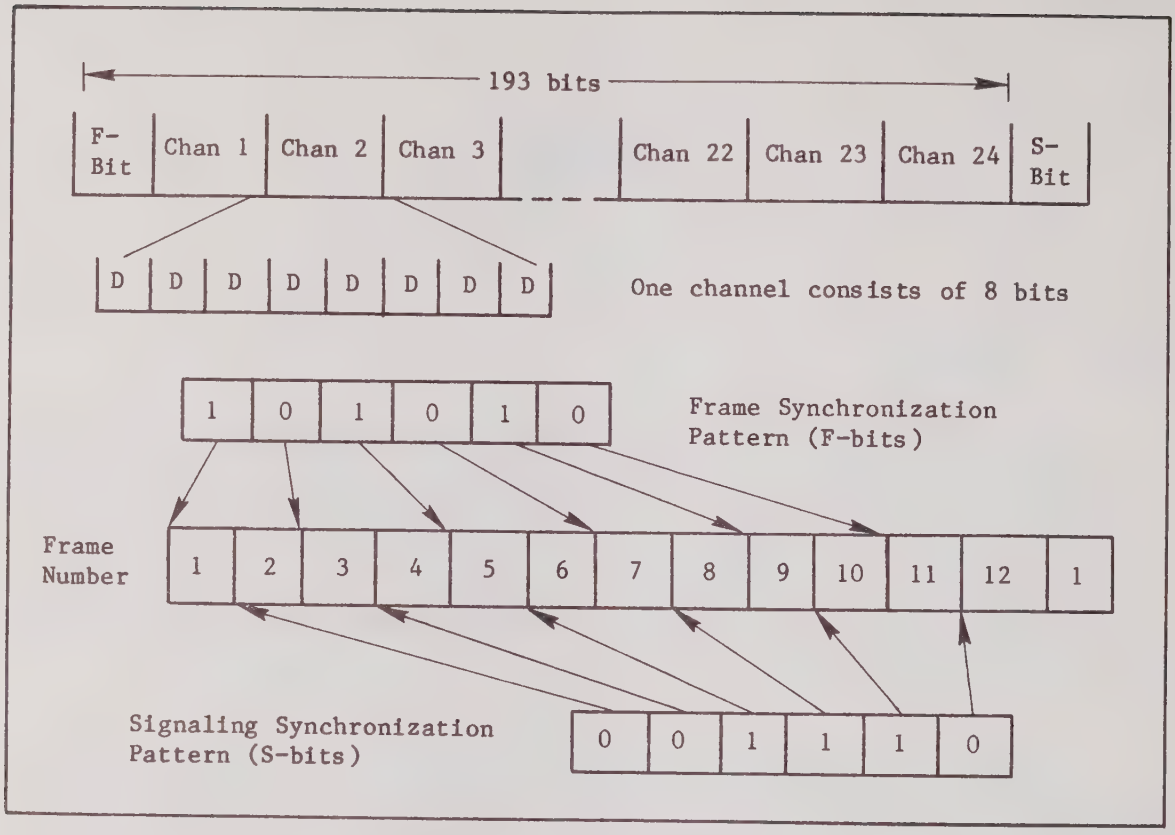
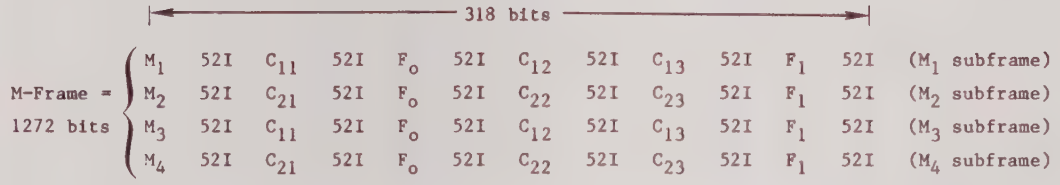


Figure 4.1. DS1 Format

The switching supplies operate on 115/220V ac, 50/60 Hz and/or from a -22V to -60V dc, positive ground, station battery connection. Both ac and dc sources can be connected simultaneously. The dc input and rectified ac input are "diode-ORed" to allow the highest source potential to drive the power supply circuits.

A. AC/DC INPUT POWER SOURCES

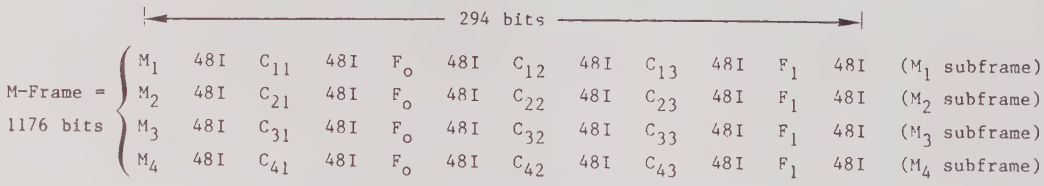
Figure 4.4 is a block diagram of input power source distribution for the Model 4653A Transmitter. The rear panel schematic is shown in Figure 7.31. Both sides of the ac power source (hot and neutral) are "switch-interrupted" while the third wire safety ground is connected directly to the chassis. The applied ac is reduced through transformer T1 to approximately 55 volts ac RMS which is then rectified by diode bridge CR3 on the Rectifier and Filter Assem-


318 bits
M-Frame = 1272 bits
M1 52I C11 52I Fo 52I C12 52I C13 52I F1 52I (M1 subframe)
M2 52I C21 52I Fo 52I C22 52I C23 52I F1 52I (M2 subframe)
M3 52I C11 52I Fo 52I C12 52I C13 52I F1 52I (M3 subframe)
M4 52I C21 52I Fo 52I C22 52I C23 52I F1 52I (M4 subframe)

LEGEND:
1. An M-Frame consists of four subframes defined by the Mn bit.
   M_1 = 0, M_2 = 1, M_3 = 1, M_4 = 0 or 1 (X-bit)
2. The F_o bits are always "0's".
3. The F_1 bits are always "1's".
4. The C bits are all "0" unless a stuff is to occur in a particular subframe, in which case they are all changed to "1's" in that subframe. Channel 1 stuffs occur in the M_1 or M_3 subframes, and Channel 2 stuffs occur in the M_2 or M_4 subframes. Channel "n" stuffs in the third channel "n" data bit after the Cn3 bit.
5. 52I; Location of 52 information bits, 26 for Channel 1 alternating with 26 for Channel 2.

Operational Notes:
1. The **Analyzer** declares F-bits are "In-Frame" when 8 successive F-bits agree with the predicted pattern, and declares "Out-of-Frame" when 3 or more F-bit errors occur in an M-Frame.
2. The **Analyzer** declares M-bits are "In-Frame" when the sequence "011" is found, and declares "Out-of-Frame" when 3 successive M-Frames have M-bit errors.

Figure 4.2. DS1C Format


294 bits
M-Frame = 1176 bits
M1 48I C11 48I Fo 48I C12 48I C13 48I F1 48I (M1 subframe)
M2 48I C21 48I Fo 48I C22 48I C23 48I F1 48I (M2 subframe)
M3 48I C31 48I Fo 48I C32 48I C33 48I F1 48I (M3 subframe)
M4 48I C41 48I Fo 48I C42 48I C43 48I F1 48I (M4 subframe)

LEGEND:
1. An M-Frame consists of four subframes defined by the Mn bit. M_1 = 0, M_2 = 1, M_3 = 1, M_4 = 0 or 1 (X-bit)
2. The F_o bits are always "0's".
3. The F_1 bits are always "1's".
4. The C bits are all "0" unless a stuff is to occur in a particular subframe, in which case they are all changed to "1s" in that subframe. Channel "n" stuffs occur in the Mn subframes at the first channel "n" data bit after the F_i bit. Where n = 1, 2, 3, or 4.
5. 48I; Location of 48 information bits, 12 from each of the 4 channels.

Operational Notes:

1. The **Analyzer** declares F-bits are "In-Frame" when 8 successive F-bits agree with the predicted pattern, and declares "Out-of-Frame" when 3 or more F-bit errors occur in an M-Frame.
2. The **Analyzer** declares M-bits are "In-Frame" when the sequence "011" is found, and declares "Out-of-Frame" when 3 successive M-Frames have M-bit errors.

Figure 4.3. DS2 Format

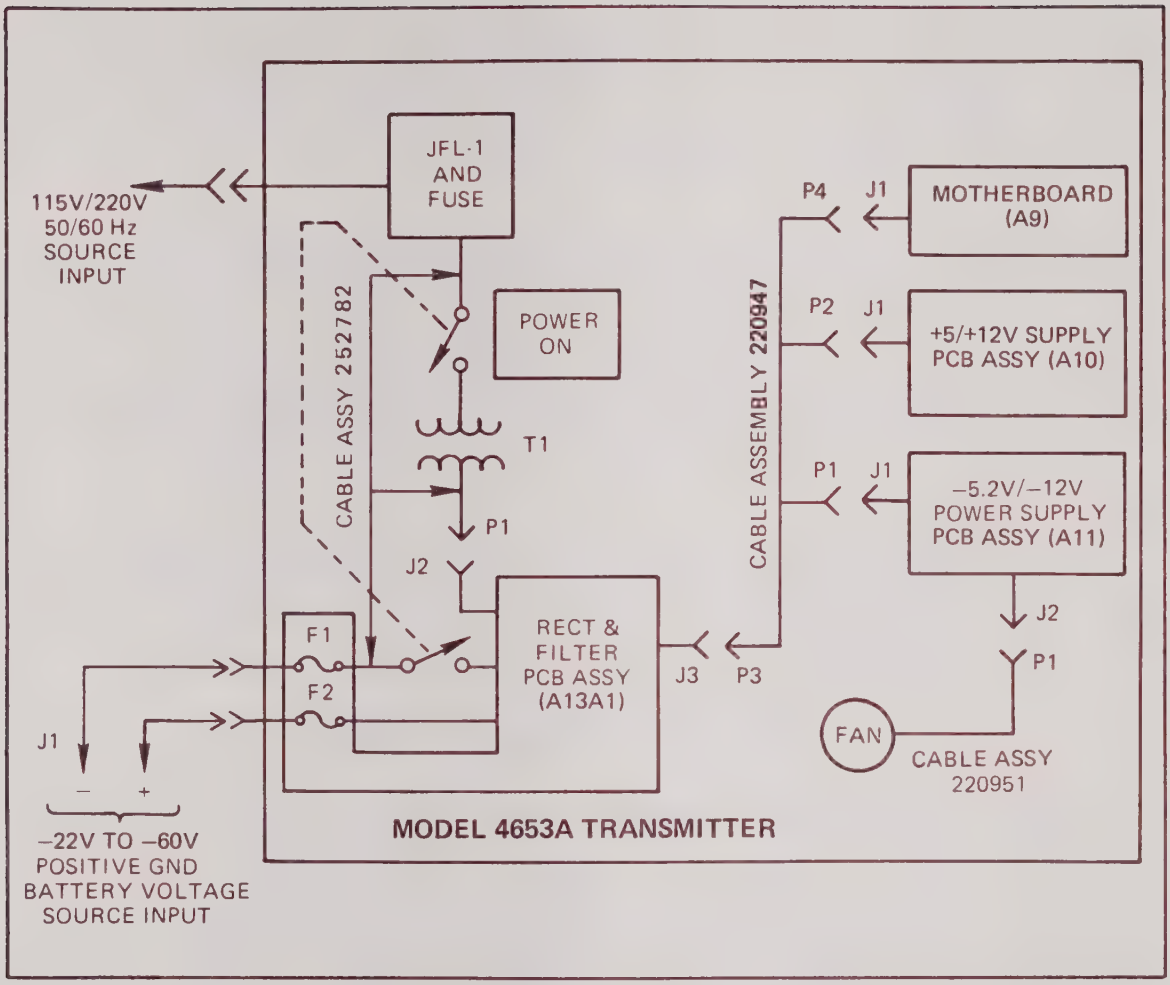


Figure 4.4. Input AC/DC Power Source Distribution Block Diagram

bly PCB. The output voltage from CR3 is a nominal -55V dc. The voltage is filtered by capacitors C4 and C5 and applied to one terminal of diode bridge CR2.

If a Station Battery dc source of -22V to -60V (positive ground) is applied to the rear panel DC INPUT connector (J1), both the source and the equipment are fuse protected (F1 and F2 on the Rectifier and Filter Assembly PCB). The negative source line is interrupted by contacts of the front panel POWER ON switch. When closed, the switch contacts apply the battery source voltage through a filter network of L1, C1, C2, and C3 to a terminal of diode

bridge CR2. The filter network removes induced noise components and transients from reflecting into the Station Battery source. A diode, CR1, is part of this filtering network and also provides protection should the Station Battery source polarity be accidentally reversed.

The two dc sources are connected at specific terminals of diode bridge CR2. The source having the larger potential will be passed by its respective diode in the CR2 bridge and reverse biasing the opposite source diode from conduction. In this manner, the two power sources are diode ORed, the larger potential supplying operating power, and the lower potential in ready reserve if needed.

Power distribution from the Rectifier and Filter Assembly PCB for a Model 4653A Transmitter is shown in Figure 4.4. The diagram shows power distribution to the boards and fan.

B. -5.2V/-12V DC POWER SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY

General. The -5.2V/-12V DC Power Supply PCB uses a pulse width modulation circuit where varying the duty cycle of a fixed frequency pulse stream produces an adjustable regulated dc voltage output. The output is sensed and fed back into the pulse width modulator which controls pulse width as needed to maintain a constant voltage. A block diagram of the -5.2V/-12V DC Power Supply PCB Assembly is shown in Figure 4.5. Components U1 and U3 each contain all the active circuitry necessary to implement a pulse width modulator except for the power switching transistor. Components used with U1 or U3 are necessary to set the desired operating frequency, provide voltage adjustment, or other supporting functions. Other circuitry included on the PCB assembly provides for overvoltage protection, voltage regulation, and feedback control. In summary, a -22V to -60 V dc input is switched through power transistors, under control of a pulse width modulator, to produce regulated -5.2V and a -12.0V dc source supplies.

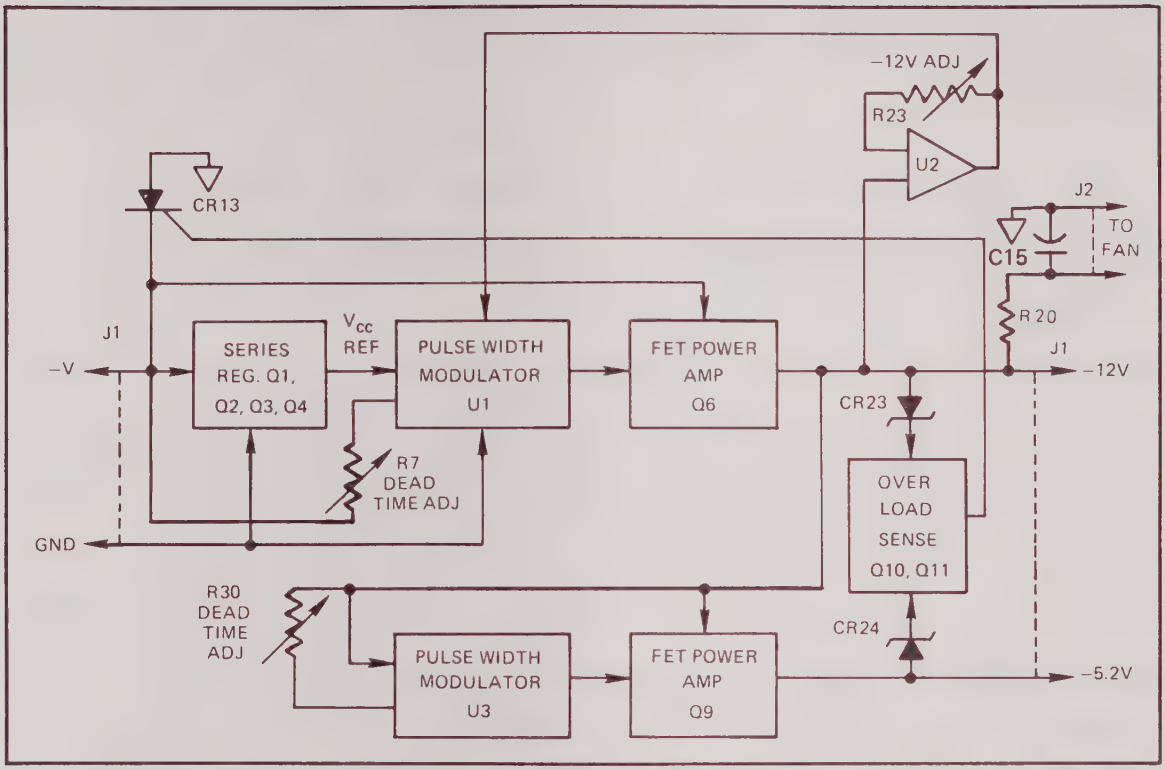


Figure 4.5. The -5.2V/-12V DC Power Supply PCB Assembly, Block Diagram

Series Regulator Circuit. The schematic diagram for the -5.2V/-12V dc Power Supply PCB Assembly is shown in Figure 7.20. A regulated voltage is required to operate a pulse width modulator circuit. The applied source voltage of -22V to -60V must also be regulated to supply a nominal 12V to pulse width modulator U1. Transistors Q1 through Q4 and associated components are connected as a series regulator producing a 12V output for U1. Note that the "-V" input is common to the series regulator circuit and the pulse width modulator. The regulator output, measured at test point TP1, will be +12 volts higher than the applied -22V to -60V input and not referenced to ground. The diode CR5 provides reverse voltage protection, while zener diode CR6, provides overvoltage protection for U1.

-12V DC Switching Regulator. All regulated dc sources produced by the Model 4563A power supply, use an SG3524 (or equivalent) Pulse Width Modulator component. A typical data sheet specifying the parameters of the SG3524 and describing the internal operation is provided in Figure 4.6 (8 sheets). The

following description details the external component connections and their respective interaction with the Pulse Width Modulator (hereafter referred to as the PWM).

The PWM provides an internally stabilized reference voltage at pin 16 which is used as reference for "Dead Time Adjust" as well as several bias voltages. The "Dead Time Adjust" corresponds to the time when the PWM outputs are forced OFF. This is required in push-pull arrangements to guarantee that both outputs cannot be ON simultaneously. When used as a single-ended drive (see Figure 7.20), "Dead Time Adjust" establishes the maximum output current by setting the maximum duty cycle. Variable resistor R7 (Dead Time Adjust for U1) is properly set by operating the -5.2V/-12V Power Supply PCB into a full load with a minimum input potential (-22V dc). Variable resistor R7 is adjusted, with minimum input potential (-22V dc), clockwise to a point where the reference voltage (at U1, pin 16) starts going out-of-regulation and is then reversed two turns, counterclockwise. The reference voltage is also divided by resistors R10 and R11 to bias the unused "plus" input of the internal amplifier (U1, pin 2) to an acceptable midrange point. The reference voltage is divided by resistors R16 and R17 to establish the current limit reference (U1, pin 5) to approximately 3.5 Amperes. Components R8 and C6 will hold the PWM outputs OFF momentarily on initial power-up to allow voltages to stabilize before the PWM begins to regulate.

Components C10 and R14 determine the PWM operating frequency at 40 kHz. Since the push-pull outputs of the PWM (U1, pins 11 and 14) are connected to each other, the drive signal into the gate of transistor Q6 will also be 40 kHz. This driving signal can be monitored at test point TP3. Capacitor C11, connected to the PWM oscillator output (U1, pin 3), sets the minimum "Dead Time" to be greater than 0.5 microseconds. Resistor R13 biases the Shutdown Input (U1, pin 10) to a level where this function has no effect on the PWM operation. Components L1 and C8 filter the feedback signal applied to the Current Limit Sense (+C.L. Sense at U1, pin 4). If the Current Limit voltage

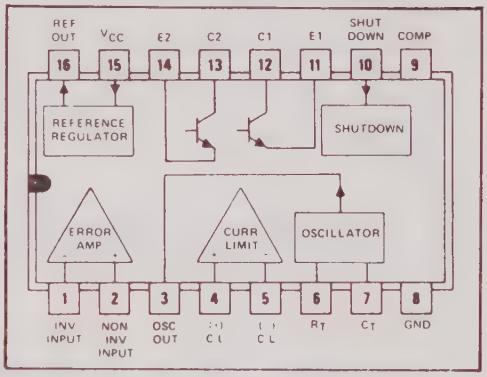
LINEAR INTEGRATED CIRCUITS

TYPES SG1524, SG2524, SG3524 REGULATING PULSE WIDTH MODULATORS

BULLETIN NO. DL-S 12495, APRIL 1977

- Complete PWM Power Control Circuitry
- Uncommitted Outputs for Single-Ended or Push-Pull Applications
- Low Standby Current . . . 8 mA Typ
- Interchangeable With Silicon General SG1524, SG2524, and SG3524, Respectively

SG1524 . . . J
SG2524, SG3524 . . . J OR N
DUAL-IN-LINE PACKAGE (TOP VIEW)



description

The SG1524, SG2524, and SG3524 incorporate on single monolithic chips all the functions required in the construction of a regulating power supply, inverter, or switching regulator. They can also be used as the control element for high-power-output applications. The SG1524 family was designed for switching regulators of either polarity, transformer-coupled dc-to-dc converters, transformerless voltage doublers, and polarity converter applications employing fixed-frequency, pulse-width-modulation techniques. The complementary output allows either single-ended or push-pull application. Each device includes an on-chip regulator, error amplifier, programmable oscillator, pulse-steering flip-flop, two uncommitted pass transistors, a high-gain comparator, and current-limiting and shut-down circuitry.

The SG1524 is characterized for operation over the full military temperature range of −55°C to 125°C. The SG2524 and SG3524 are characterized for operation from 0°C to 70°C

functional block diagram

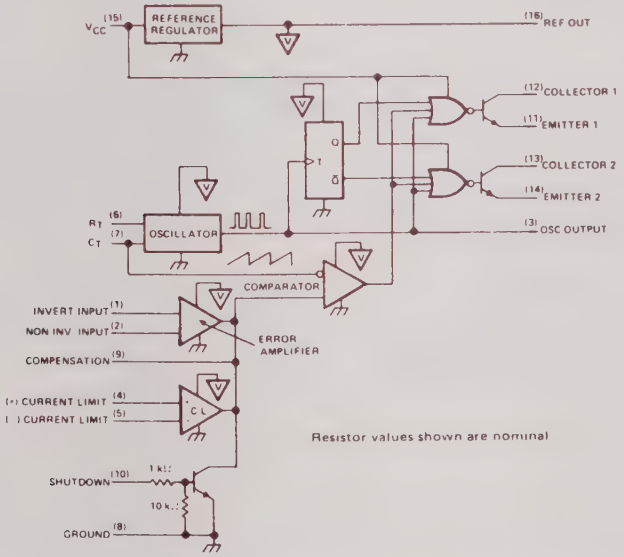


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Figure 4.6. Pulse Width Modulator SG3524, Data Sheets (Sheet 1 of 8)

TYPES SG1524, SG2524, SG3524
REGULATING PULSE WIDTH MODULATORS

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

Supply Voltage, V_{CC} (See Notes 1 and 2) . . . . . 40 V
Collector Output Current . . . . . 100 mA
Reference Output Current . . . . . 50 mA
Current Through C_T Terminal . . . . . −5 mA
Continuous Total Dissipation at (or below) 25°C Free-Air Temperature (See Note 3) . . . . . 1000 mW
Operating Free-Air Temperature Range: SG1524 . . . . . −55°C to 125°C
SG2524, SG3524 . . . . . 0°C to 70°C
Storage Temperature Range . . . . . −65°C to 150°C

NOTES: 1. All voltage values are with respect to network ground terminal.
2. The reference regulator may be bypassed for operation from a fixed 5-volt supply by connecting the V_{CC} and reference output pins both to the supply voltage. In this configuration the maximum supply voltage is 6 volts.
3. For operation above 25°C free-air temperature, see Dissipation Derating Curves, page 124.

recommended operating conditions

	SG1524		SG2524, SG3524		UNIT
	MIN	MAX	MIN	MAX	
Supply voltage, V_{CC}	8	40	8	40	V
Reference output current	0	50	0	50	mA
Current thru C_T terminal	−0.03	−2	−0.03	−2	mA
Timing resistor, R_T	1.8	100	1.8	100	kΩ
Timing capacitor, C_T	0.001	0.1	0.001	0.1	μF
Operating free-air temperature	−55	125	0	70	°C

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 20 V, f = 20 kHz (unless otherwise noted)

reference section

PARAMETER	TEST CONDITIONS†	SG1524			SG2524			SG3524			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	MIN	TYP‡	MAX	
Output voltage		4.8	5	5.2	4.8	5	5.2	4.6	5	5.4	V
Input regulation	V_{CC} = 8 to 40 V		10	20		10	20		10	30	mV
Ripple rejection	f = 120 Hz		66			66			66		dB
Output regulation	I_O = 0 to 20 mA		20	50		20	50		20	50	mV
Output voltage change with temperature	T_A = MIN to MAX		0.6	2		0.3	1		0.3	1	%
Short-circuit output current §	V_{ref} = 0		100			100			100		mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values except output voltage change with temperature are at T_A = 25°C.
§ Duration of the short-circuit should not exceed one second.

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Figure 4.6. Pulse Width Modulator SG3524, Data Sheets (Sheet 2 of 8)

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 20 V, f = 20 kHz (unless otherwise noted)

error amplifier section

PARAMETER	TEST CONDITIONS	SG1524, SG2524			SG3524			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
Input offset voltage	V_{IC} = 2.5 V		0.5	5		2	10	mV
Input bias current	V_{IC} = 2.5 V		2	10		2	10	μA
Open-loop voltage amplification		72	80		60	80		dB
Common-mode input voltage range	T_A = 25°C	1.8 to 3.4			1.8 to 3.4			V
Common-mode rejection ratio			70			70		dB
Unity-gain bandwidth			3			3		MHz
Output swing	T_A = 25°C	0.5		3.8	0.5		3.8	V

oscillator section

PARAMETER	TEST CONDITIONS†	MIN	TYP‡	MAX	UNIT
Frequency	C_T = 0.001 μF, R_T = 2 kΩ		450		kHz
Standard deviation of frequency§	All values of voltage, temperature, resistance, and capacitance constant		5		%
Frequency change with voltage	V_{CC} = 8 to 40 V, T_A = 25°C			1	%
Frequency change with temperature	T_A = MIN to MAX			2	%
Output amplitude at pin 3			3.5		V
Output pulse width at pin 3	C_T = 0.01 μF		0.5		μs

comparator section

PARAMETER	TEST CONDITIONS	MIN	TYP‡	MAX	UNIT
Maximum duty cycle, each output		45			%
Input threshold voltage at pin 9	Zero duty cycle		1		V
	Maximum duty cycle		3.5		
Input bias current			−1		μA

current limiting section

PARAMETER	TEST CONDITIONS	SG1524, SG2524			SG3524			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
Input voltage range (either input)		−0.7 to +1			−0.7 to +1			V
Sense voltage for 2-V output at pin 9	V(pin 2) − V(pin 1) ≥ 50 mV, T_A = 25°C	190	200	210	180	200	220	mV
Sense voltage	T_A = MIN to MAX		0.2			0.2		mV/°C

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡All typical values except for temperature coefficients are at T_A = 25°C.

§Standard deviation is a measure of the statistical distribution about the mean as derived from the formula $\sigma = \sqrt{\frac{\sum_{n=1}^{N} (X_n - X)^2}{N-1}}$

Figure 4.6. Pulse Width Modulator SG3524, Data Sheets (Sheet 3 of 8)

TYPES SG1524, SG2524, SG3524
REGULATING PULSE WIDTH MODULATORS

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 20 V, f = 20 kHz (unless otherwise noted)

output section

PARAMETER	TEST CONDITIONS		MIN	TYP‡	MAX	UNIT
Collector-emitter breakdown voltage			40			V
Collector off-state current	V_{CE} = 40 V			0.01	50	μA
Collector-emitter saturation voltage	I_C = 50 mA			1	2	V
Emitter output voltage	V_C = 20 V,	I_E = −250 μA	17	18		V
Turn-off voltage rise time	R_C = 2 kΩ			0.2		μs
Turn-on voltage fall time	R_C = 2 kΩ			0.1		μs

total device

PARAMETER	TEST CONDITIONS		MIN	TYP‡	MAX	UNIT
Standby current	V_{CC} = 40 V, Pin 2 at 2 V,	Pins 1,4,7,8,9,11,14 grounded, All other inputs and outputs open		8	10	mA

‡All typical values except for temperature coefficients are at T_A = 25°C

PARAMETER MEASUREMENT INFORMATION

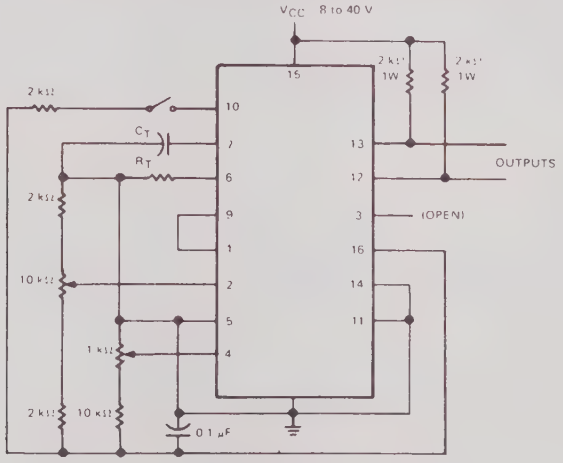
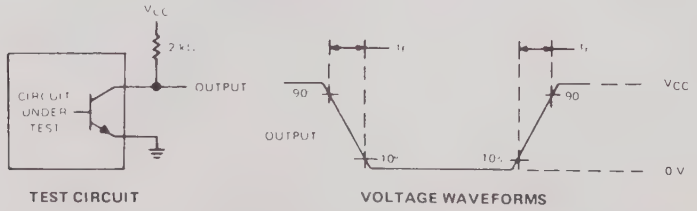


FIGURE 1–GENERAL TEST CIRCUIT



TEST CIRCUIT VOLTAGE WAVEFORMS

FIGURE 2–SWITCHING TIMES

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Figure 4.6. Pulse Width Modulator SG3524, Data Sheets (Sheet 4 of 8)

TYPICAL CHARACTERISTICS

OPEN LOOP VOLTAGE AMPLIFICATION
OF ERROR AMPLIFIER
vs
FREQUENCY

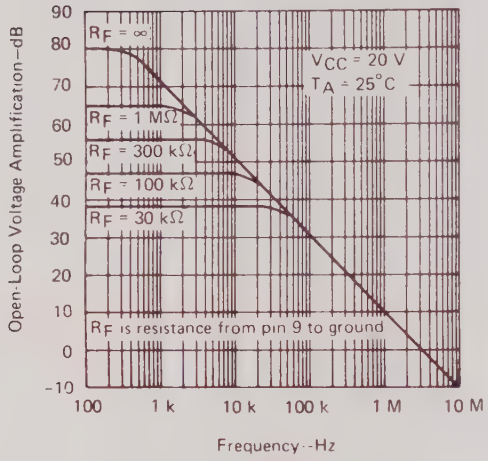

FIGURE 3

OSCILLATOR FREQUENCY
vs
TIMING RESISTANCE

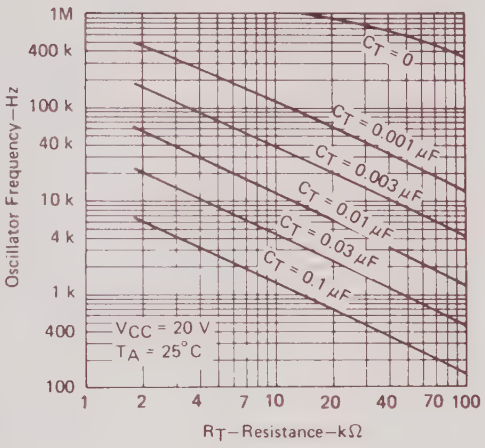

FIGURE 4

OUTPUT DEAD TIME
vs
TIMING CAPACITANCE VALUE

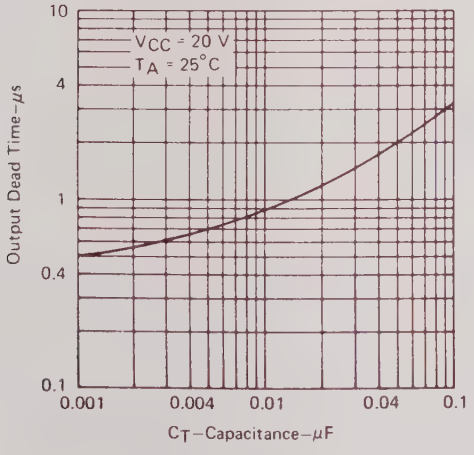

FIGURE 5

Figure 4.6. Pulse Width Modulator SG3524, Data Sheets (Sheet 5 of 8)

TYPES SG1524, SG2524, SG3524
REGULATING PULSE WIDTH MODULATORS

PRINCIPLES OF OPERATION

The SG1524† is a fixed-frequency pulse-width-modulation voltage-regulator control circuit. The regulator operates at a fixed frequency that is programmed by one timing resistor R_T and one timing capacitor C_T. R_T establishes a constant charging current for C_T. This results in a linear voltage ramp at C_T, which is fed to the comparator providing linear control of the output pulse width by the error amplifier. The SG1524 contains an on-board 5-volt regulator that serves as a reference as well as supplying the SG1524's internal regulator control circuitry. The internal reference voltage is divided externally by a resistor ladder network to provide a reference within the common-mode range of the error amplifier as shown in Figure 6, or an external reference may be used. The output is sensed by a second resistor divider network and the error signal is amplified. This voltage is then compared to the linear voltage ramp at C_T. The resulting modulated pulse out of the high-gain comparator is then steered to the appropriate output pass transistor (Q1 or Q2) by the pulse-steering flip-flop, which is synchronously toggled by the oscillator output. The oscillator output pulse also serves as a blanking pulse to assure both outputs are never on simultaneously during the transition times. The width of the blanking pulse is controlled by the value of C_T. The outputs may be applied in a push-pull configuration in which their frequency is half that of the base oscillator, or paralleled for single-ended applications in which the frequency is equal to that of the oscillator. The output of the error amplifier shares a common input to the comparator with the current-limiting and shut-down circuitry and can be overridden by signals from either of these inputs. This common point is also available externally and may be employed to control the gain of, or to compensate, the error amplifier, or to provide additional control to the regulator.

TYPICAL APPLICATION DATA

oscillator

The oscillator controls the frequency of the SG1524 and is programmed by R_T and C_T as shown in Figure 4.

$$f \approx \frac{1.15}{R_T C_T}$$

where R_T is in kilohms
C_T is in microfarads
f is in kilohertz

Practical values of C_T fall between 0.001 and 0.1 microfarad. Practical values of R_T fall between 1.8 and 100 kilohms. This results in a frequency range typically from 140 hertz to 500 kilohertz.

blanking

The output pulse of the oscillator is used as a blanking pulse at the output. This pulse width is controlled by the value of C_T as shown in Figure 5. If small values of C_T are required, the oscillator output pulse width may still be maintained by applying a shunt capacitance from pin 3 to ground.

synchronous operation

When an external clock is desired, a clock pulse of approximately 3 volts can be applied directly to the oscillator output terminal. The impedance to ground at this point is approximately 2 kilohms. In this configuration R_T C_T must be selected for a clock period slightly greater than that of the external clock.

If two or more SG1524 regulators are to be operated synchronously, all oscillator output terminals should be tied together. The oscillator programmed for the minimum clock period will be the master from which all the other SG1524's operate. In this application, the C_T R_T values of the slaved regulators must be set for a period approximately 10% longer than that of the master regulator. In addition, C_T (master) = 2 C_T (slave) to ensure that the master output pulse, which occurs first, has a wider pulse width and will subsequently reset the slave regulators.

†Throughout these discussions, references to SG1524 apply also to SG2524 and SG3524

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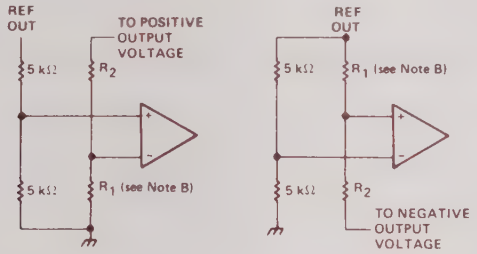
Figure 4.6. Pulse Width Modulator SG3524, Data Sheets (Sheet 6 of 8)

TYPICAL APPLICATION DATA

voltage reference

The 5-volt internal reference may be employed by use of an external resistor divider network to establish a reference within the error amplifiers common-mode voltage range (1.8 to 3.4 volts) as shown in Figure 6, or an external reference may be applied directly to the error amplifier. For operation from a fixed 5-volt supply, the internal reference may be bypassed by applying the input voltage to both the V_{CC} and V_{REF} terminals. In this configuration, however, the input voltage is limited to a maximum of 6 volts.



$$V_O \approx 2.5\,V\frac{R1 + R2}{R1} \qquad \frac{R1\,R2}{R1 + R2} = 2.5\ k\Omega$$

FIGURE 6–ERROR AMPLIFIER BIAS CIRCUITS

error amplifier

The error amplifier is a differential-input transconductance amplifier. The output is available for dc gain control or ac phase compensation. The compensation node (pin 9) is a high-impedance node (R_L = 5 megohms). The gain of the amplifier is $A_V = (0.002\ \Omega^{-1})\ R_L$ and can easily be reduced from a nominal 10,000 by an external shunt resistance from pin 9 to ground. Refer to Figure 3 for data.

compensation

Pin 9, as discussed above, is made available for compensation. Since most output filters will introduce one or more additional poles at frequencies below 200 hertz, which is the pole of the uncompensated amplifier, introduction of a zero to cancel one of the output filter poles is desirable. This can best be accomplished with a series RC circuit from pin 9 to ground in the range of 50 kilohms and 0.001 microfarads. Other frequencies can be canceled by use of the formula $f \approx 1/RC$.

shut down circuitry

Pin 9 can also be employed to introduce external control of the SG1524. Any circuit that can sink 200 microamperes can pull the compensation terminal to ground and thus disable the SG1524.

In addition to constant-current limiting, pins 4 and 5 may also be used in transformer-coupled circuits to sense primary current and shorten an output pulse should transformer saturation occur. Pin 5 may also be grounded to convert pin 4 into an additional shutdown terminal.

Figure 4.6. Pulse Width Modulator SG3524, Data Sheets (Sheet 7 of 8)

TYPES SG1524, SG2524, SG3524
REGULATING PULSE WIDTH MODULATORS

TYPICAL APPLICATION DATA

current limiting

A current-limiting sense amplifier is provided in the SG1524. The current-limiting sense amplifier exhibits a threshold of 200 millivolts and must be applied in the ground line since the voltage range of the inputs is limited to +1 volt to −0.7 volt. Caution should be taken to ensure the −0.7-volt limit is not exceeded by either input, otherwise damage to the device may result.

Fold-back current limiting can be provided with the network shown in Figure 7. The current-limit schematic is shown in Figure 8.

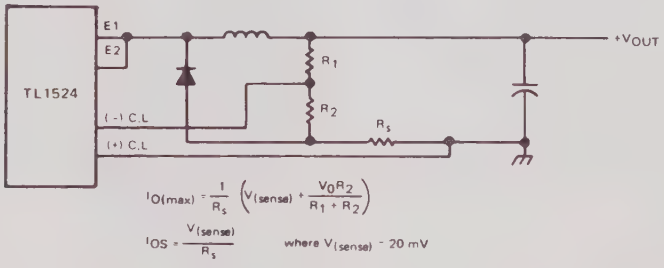


FIGURE 7–FOLDBACK CURRENT LIMITING FOR SHORTED OUTPUT CONDITIONS

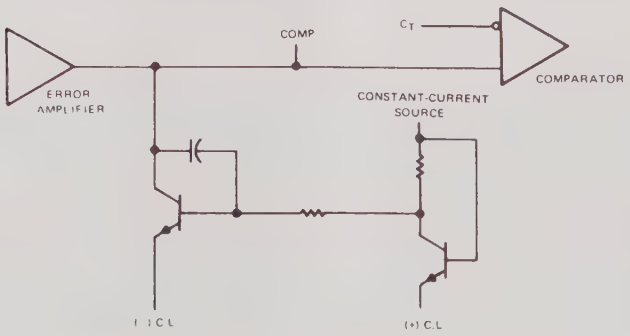


FIGURE 8–CURRENT-LIMIT SCHEMATIC

output circuitry

The SG1524 contains two identical n-p-n transistors the collectors and emitters of which are uncommitted. Each transistor has antisaturation circuitry that limits the current through that transistor to a maximum of 100 milliamperes for fast response

Figure 4.6. Pulse Width Modulator SG3524, Data Sheets (Sheet 8 of 8)

developed across resistor R18 permits the voltage at -C.L. Sense (U1, pin 5) to exceed the voltage at +C.L. Sense (U1, pin 4), the PWM will not widen the pulse width to permit an increase in output current.

The collectors of the PWM output transistors are connected to the V_{CC} input source and the emitters are connected to each other to drive the switching power transistor, Q6. Components R15, Q5, and CR9 increase the drive capability by providing rapid discharge of Q6 Gate capacitance. This effects a rapid turn-off as well as turn-on. The switching power transistor, Q6, is a FET device that is OFF (or open circuit) when V_{GS} equals 0V dc and ON (or closed circuit with 0.25 ohm max) when V_{GS} equals 10V dc. Diode CR10 protects Q6 from reverse voltage. Network components L2, CR11, and R19 reduce ringing and overvoltage transients on the Drain of Q6. The final -12V dc output is filtered by components L3, C17, L4, and C28 with diode CR12 providing a current path for the inductors when transistor Q6 is switched OFF.

Feedback control and frequency compensation for the PWM is made from a -12V dc source, regulated by component U2 through transistor Q7 which provides level shifting. Variable resistor R23 is adjusted to produce the -12V dc output while components C16, R21, C18, R28, C9, and R12 provide frequency compensation. Components CR14 and R26 provide bias voltage for the "plus" input of component U2.

The separate -12V dc source used to operate the fan is additionally filtered by components R20 and C15 to isolate the dc fan from the PWM. Diode CR23, transistor Q10, and connecting components, provide an overvoltage protection "crowbar" circuit. When the output voltage exceeds approximately 15V dc, transistor Q10 is switched ON and triggers the SCR diode, CR13, to short the -V input and blow the appropriate input fuse. Resistor R25 is rated at 100-ohms/3 Watts, and is provided to load the -12V dc supply when normal loads are removed. This is necessary because this switching power supply cannot operate into a zero load condition. Some loading must exist for the circuit to remain in regulation.

-5.2V DC Switching Regulator. In principle, the -5.2V dc switching regulator circuit operates identically to the -12V dc switching regulator circuit. There are several circuit changes to accommodate the different voltage range. The first difference to note is PWM U3 operates between the regulated -12V dc supply and ground, rather than the floating supply used with PWM U1. The schematic (Figure 7.20) shows PWM U3, pin 15 is grounded and U3, pin 8 connects to the regulated -12V dc source. The operating frequency used by PWM U3 is set for 65 kHz, which drives the Gate of transistor Q9. This driving frequency can be monitored at test point TP3. The frequency is higher to simplify the necessary filtering for the -5.2V dc output which can exceed 3.0 Amperes when required.

The feedback component U4 drives transistor Q12 as a current source configuration into the PWM U3. Note that the PWM internal amplifiers are not used and the feedback signal is applied, instead, to the compensation input of the PWM. An overvoltage detector circuit using diode CR24, transistor Q11, and connected components are set to trigger at approximately 7 volts dc. This trigger signal also operates SCR diode, CR13, to short the -V input and blow the appropriate input fuse if an overvoltage condition exists. Resistor R50, rated at 50-ohms/3 Watts, loads the -5.2V dc supply when other loads are removed. This supply also requires a partial load to remain in regulation.

C. +5.0V/+12.0V DC POWER SUPPLY PRINTED CIRCUIT BOARD ASSEMBLY

General. A block diagram of the +5.0V/+12.0V dc Power Supply PCB is shown in Figure 4.7. This power supply assembly operates similar to the -5.2V/-12V dc Power Supply circuits. The major difference is the negative supply chops the -22V to -60V applied voltage into regulated sources, while this supply requires a transformer to generate positive output voltages from the negative voltage input. The +12V supply PWM operates from the same voltage source as the -12V supply PWM, but the +12V supply output signals drive a differential transformer. The +5V supply PWM operates from the regulated +12V dc output and does not require a transformer.

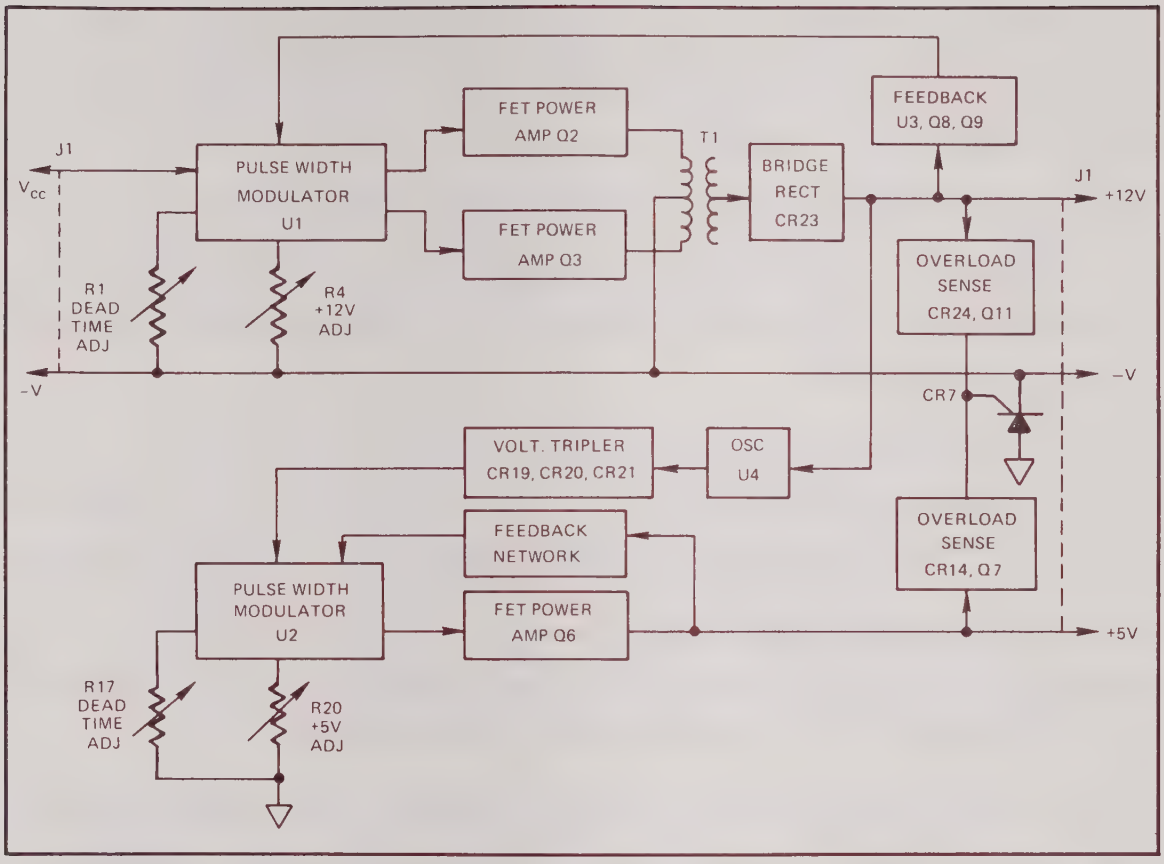


Figure 4.7. The +5.0V/+12.0V DC Power Supply PCB Assembly, Block Diagram

+12V DC Switching Regulator. The schematic diagram of the +5.0V/+12.0V dc Power Supply PCB Assembly is shown in Figure 7.22. When the +5.0V/+12.0V dc Power Supply PCB Assemby is used, it is interconnected with the -5.2V/-12.0V dc Power Supply PCB Assembly through Cable Assembly 220947 which make the functions "-V", "V_{CC}", and "GND" common to both supply assemblies. The +12V dc PWM, U1, uses the common functions to operate very similar to the -12V dc switching regulator. Components C5 and R9 set the operating frequency to 40 kHz, while capacitor C6 maintains a minimum "Dead Time" at not less than 0.5 microseconds. Current limiting, "Dead Time Adjust" (through variable resistor R1) and the power-up delay functions, are also similar to the -5.2V/-12.0V dc Power Supply PCB Assembly.

However, the output signals from the +12V PWM drive FET Power Amplifiers Q2 and Q3 which, in turn, drive transformer T1 in a differential push-pull arrangement. The Gates of FET Power Amplifiers are driven through transistors Q1 and Q4 to improve the Gate drive signal rise and fall times. Capacitor C7 filters the dc voltage input to the transformer and components C8 and R14 load the transformer coil to reduce switching transients. The transformer secondary voltage is full-wave rectified by a fast recovery diode bridge, CR23; and the bridge output is filtered by components L4 and C28 to become the regulated +12.0V dc output voltage.

Resistors R39 and R40 divide voltage from the +12.0V dc output to establish a midrange input signal level for component U3. This input signal is amplified and then level shifted through transistors Q8 and Q9 to provide feedback voltage into the +12V dc PWM at VIN(-), pin 1. The feedback voltage controls the duty cycle of the FET Power Amplifier "Gate drive" signal to regulate the resulting +12V dc rectified signal. The VIN(+), pin 2, connects to variable resistor R4 which adjusts the final output voltage.

The circuit using transistor Q11, diode CR24, and associated components, provides overvoltage protection. If the output level exceeds approximately +15 volts, the overvoltage protection circuit operates SCR diode, CR7, until the input fuse blows. Resistor R43, rated at 100-ohms/3 Watts, loads the +12V dc supply when other loads are removed. This supply requires partial loading to maintain regulation.

+5V DC Switching Regulator. The +5V dc PWM derives operating power from the regulated +12V dc output. The +12V is applied to component U4 which operates as an oscillator, and the output frequency is rectified by a voltage tripler, CR19, CR20, and CR21. Voltage at the junction of diode CR19 and capacitor C8 is approximately +25V dc which is applied to the +5V PWM. The higher voltage is required to adequately raise the FET Power Amplifier "Gate drive" signal. The FET Power Amplifier, Q6, is also connected to the regulated +12V dc source. The Gate drive signal must be raised 10 volts higher to fully switch the FET Power Amplifier into the ON state.

Components C12 and R23 set the +5V PWM to operate at approximately 65 kHz, and capacitor C13 provides a minimum "Dead Time" in excess of 0.5 microseconds. Variable resistor R17 (DEAD TIME ADJ) will establish the maximum duty cycle of the output drive pulses. It is properly adjusted when the +5V dc supply output, operating into a full load with minimum dc input of -22V dc, starts to drop out of regulation as R17 is rotated clockwise. At this point, the adjustment is given two turns counterclockwise. Proper "Dead Time Adjustment" provides the maximum output current by setting the maximum duty cycle.

Components R18 and C9 provide a power-up delay to prevent PWM, U2, from trying to regulate until the applied power source voltage has stabilized. The PWM output drive transistor emitters are connected together and drive the FET power amplifier, Q6, Gate through components Q5, R24, CR10, and CR11. The signal, monitored at test point TP4, is a 0 to 25V pulse at 65 kHz. The FET power amplifier chops the +12V dc at 65 kHz into the regulated +5V dc with filtering provided by components L2 and C15. Diode CR13 provides a conduction path for current in L2 when the FET power amplifier (Q6) is switched OFF.

A feedback "sense" voltage is filtered by components C14, R25, and R22 and returned to the "-V" input of the PWM (U2, pin 1) to control the output voltage. Additional frequency compensation is provided through capacitor C10 connected at the PWM (U2, pin 9) Compensation input. Current limit sensing is not used directly on the +5V PWM (U2) because inputs to the +12V PWM (U1, pins 4 and 5) are grounded. In this circuit arrangement, current limit is better provided through the proper setting of "Dead Time Adjust" variable resistor R17. Components Q7 and CR14 provide an overvoltage sense circuit that operates at approximately +7V dc to enable SCR diode, CR7, to shut down the source supply if overvoltage occurs.

4.3 MODEL 4653A AC LINEAR SUPPLIES

The Model 4653A Transmitter can be purchased with an AC-only linear power supply in place of the AC/DC switching power supply. The linear power supply provides a regulated +5V, +12V, -5V, and -12V dc. A block diagram of the

linear power supply is shown in Figure 4.8. The following descriptions identify the circuits in sections as shown in the block diagram. The schematic is shown in Figure 7.18.

The linear power supply consists of a power transformer, bridge rectifier, filter capacitor, voltage regulator, and an overvoltage protection circuit. The +12V supply also contains the power fail circuitry that warns the microprocessor that a power failure is occurring. The applied line voltage of 115 volts or 220 volts, 50 or 60 Hz, is applied through the power cord to the rear panel Line Filter, Voltage Select, and fuse block unit (JFL-1). The position of the voltage select PCB and the proper value fuse in the JFL-1 unit permits normal operation with either applied voltage (See Figure 5.2.). The AC line voltage is interrupted by the front panel POWER ON switch.

When the POWER ON switch is operated, ac voltage is applied to the primary winding of power transformer T1. The two secondaries of T1 provide (1) a center-tapped voltage of 32V rms @ 2.6 Amps that is applied to a diode bridge for full wave rectification, and (2) a voltage of 10V rms @ 6.0 Amps that is applied to a diode bridge for full wave rectification. The 32V source drives the +12V, -12V, and the -5V power supplies. The 10V source drives the +5V power supply. All regulated power supplies are basically the same. Therefore, only one will be described in detail; the +12V power supply.

The positive rectified voltage from the diode bridge CR4, is applied across filter capacitor C6 to the input of voltage regulator U1 to provide a regulated output of +12V which is adjustable by R12. (The +5V and -5V supplies are fixed output.) An overvoltage sensing circuit consisting of U2 and SCR Q2, protects sensitive components from overvoltage. If an overvoltage condition exists at the output of U1, component U2 senses it and enables the SCR Q2 which, in turn, shorts the input DC voltage to ground and blows the fuse F2. Diodes CR2, CR7, CR14, and CR15 are used in conjunction with the overvoltage sensing circuit to hold the voltage to a safe level until the fuse blows.

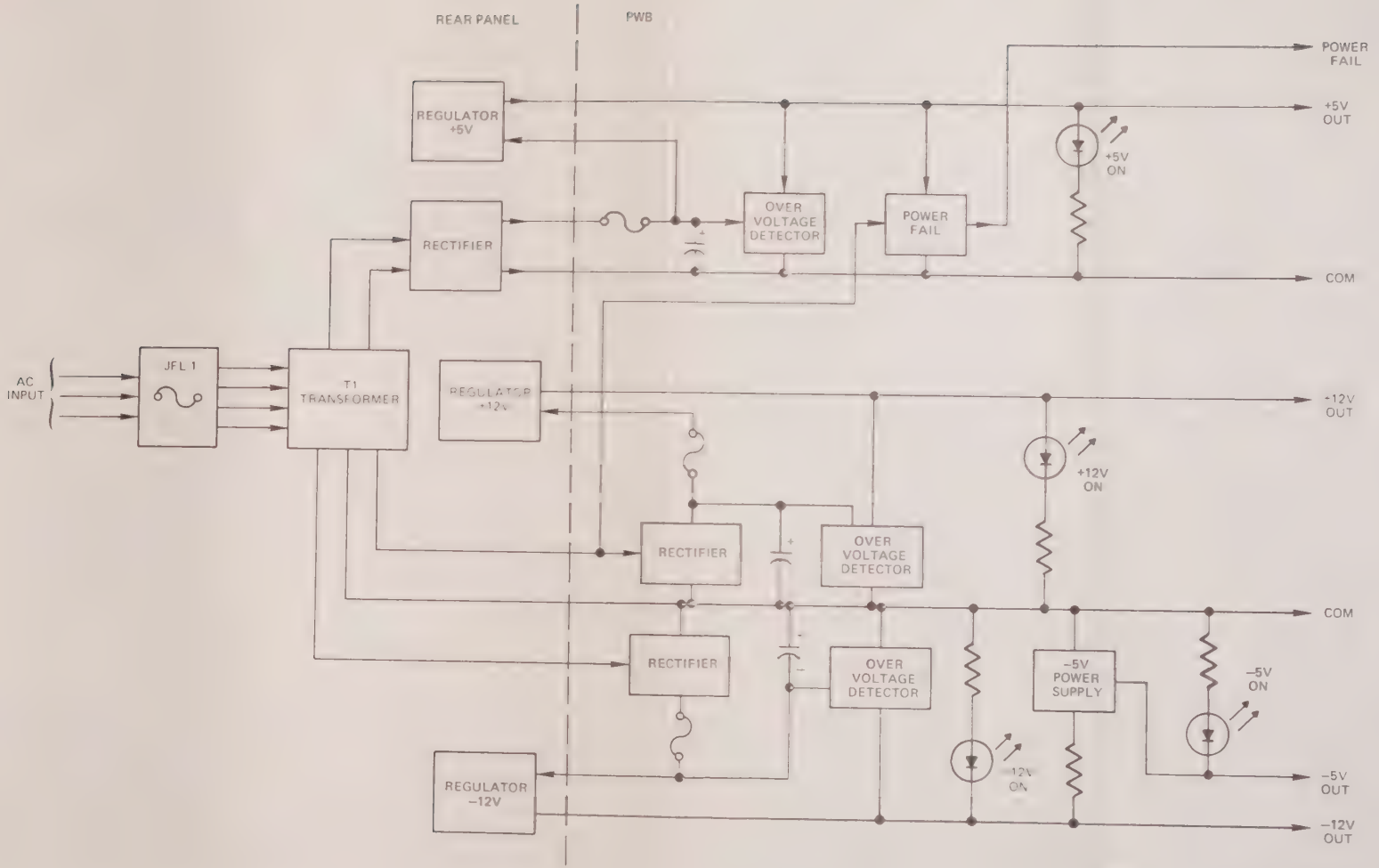


Figure 4.8. AC-Only Linear Power Supply Block Diagram

4.4 MODEL 4653A TRANSMITTER CIRCUITS

General. The Model 4653A Transmitter consists of the following major assemblies:

1. Rear Panel (A13) and Power Wiring Harness
2. -5V/-12V DC Power Supply PCB Assembly (A10) and +5V/+12V DC Power Supply PCB Assembly (A11) for units with the AC/DC Switching supply, or the +5V/+12V/-5V/-12V Power Supply PCB Assembly (A10) for units with the AC-only linear supply
3. Output Amplifier PCB Assembly (A1)
4. Data Generator PCB Assembly (A2)
5. Multiplexer PCB Assembly (A3)
6. DS1 Framing PCB Assembly (A4)
7. Error Count/Insert PCB Assembly (A5)
8. Interface PCB Assembly (A6)
9. Front Panel PCB Assembly (A12)
10. Motherboard Assembly (A9)

The rear panel, power wiring, and power supply PCB's have been described in Sections 4.2 and 4.3. The Front Panel Assembly (A12) consists of a single printed circuit board on which are mounted the various push-button switches. The thumbwheel switches are connected to the front panel PCB with a Flex circuit. The front panel PCB is connected to the Interface PCB (A5) by a ribbon cable. The BNC connectors on the front panel are connected to the Motherboard (A9) by another Flex circuit. Figure 4.9 is a block diagram of a Model 4653A Transmitter.

A. OUTPUT AMPLIFIER PCB ASSEMBLY (A1)

General. A block diagram of the Output Amplifier circuits is shown in Figure 4.10. The following descriptions identify the circuits in sections as shown in the block diagram. The schematic is shown in Figure 7.4. The Output Amplifier PCB contains four DS1/DS1C amplifiers and shaping networks along with a DS2 amplifier and cable simulators. Each amplifier converts the + Rail and - Rail data from the Multiplexer and Error Insert logic into a balanced bipolar waveform. Waveshape conditioning and output level is fixed at the DS1

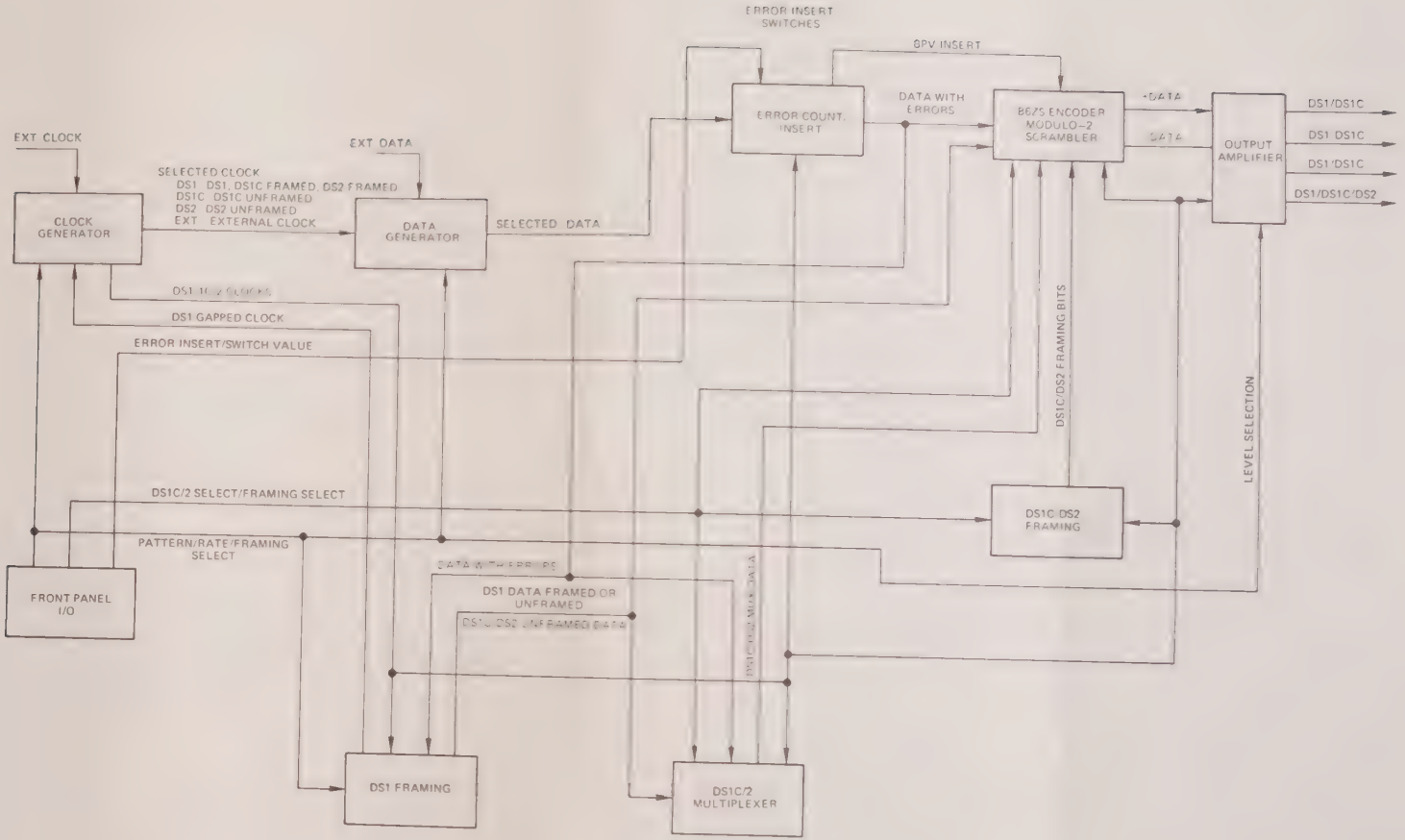


Figure 4.9. Model 4653A Transmitter, Block Diagram

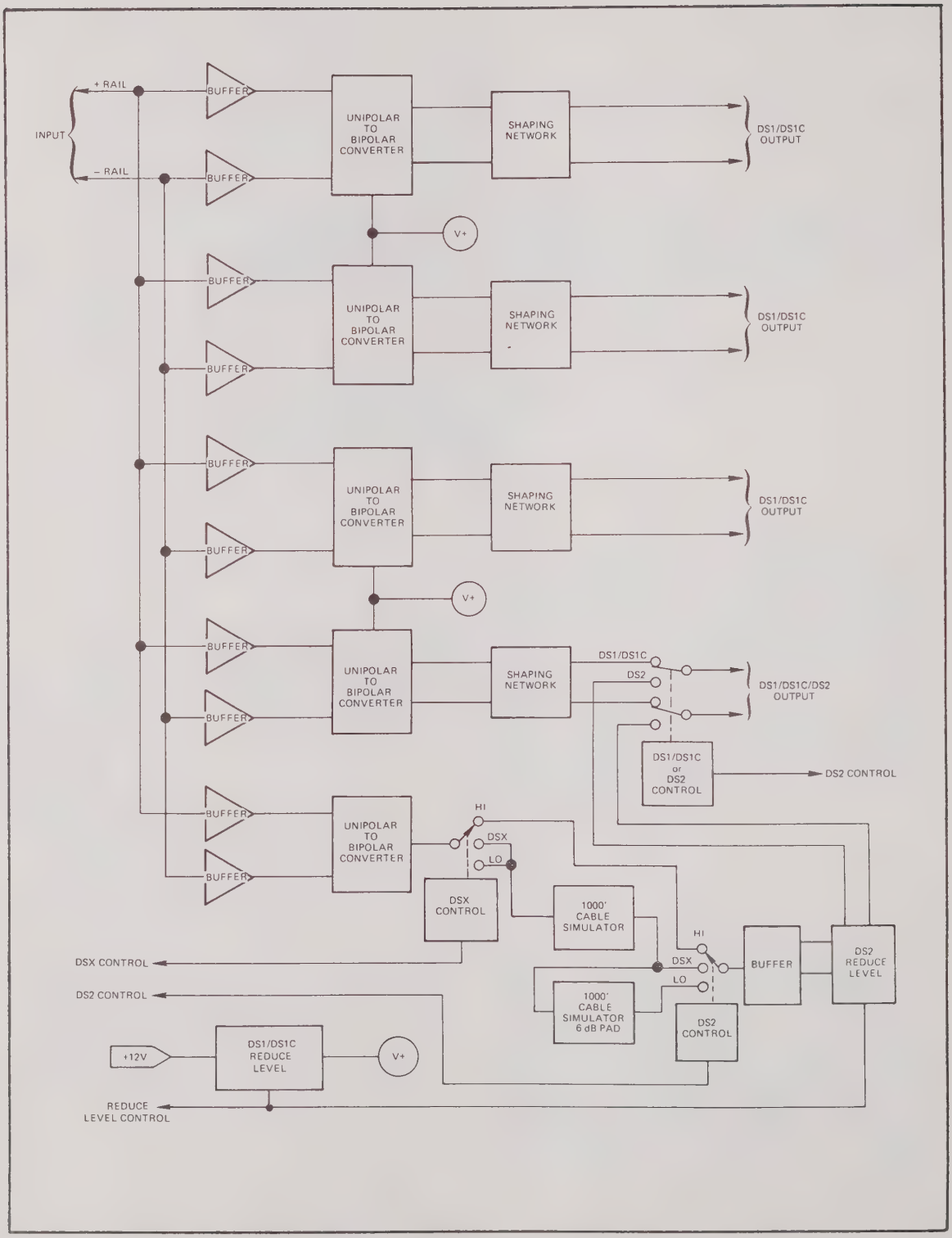


Figure 4.10. Output Amplifier PCB (A1), Block Diagram

and DS1C rate; but the DS2 output can be selected between a high level (HI), a 1000 ft. cable simulator (DSX), or twice the DSX cable length plus 6 dB of flat loss (LO).

1. Amplifiers

Since all five amplifiers are basically alike, only one will be described. The input + Rail and - Rail data drives buffers U1A and U1B. These alternately switch on and off which, in turn, drive transistors Q1 and Q2 on and off. This allows current to alternately flow in the primary of T1, which produces a bipolar output waveform in the secondary of T1. A balanced Bridged-T network composed of C4, C5, L1, R7, R8, R9, R10, R11, R12 and R13, shapes the normally rectangular waveform into one with the desirable falling edge undershoot while maintaining a high return loss.

2. Cable Simulators

The Output Amplifier PCB also contains two 1000 ft. cable simulators and a 6 dB attenuator network. The two cable simulators are identical passive Bridged-T networks. The first cable simulator consists of C24, C25, L5, L6, R59, R60, R61, R62, R82 and R83. They each simulate a 1000 ft. section of 22 gauge ABAM Cable for attenuation and phase over the frequency range of 100 KHz to 10 MHz. For the DS2-HI signal level, the output of the amplifier is fed directly to the output buffer, which will be described later. For DS2-DSX, the signal passes through one cable simulator between the output amplifier and the buffer. For DS2-LO, the signal passes through two cable simulators and also a resistive attenuator consisting of R69, R70 and R71, which attenuates the signal by an additional 6 dB.

3. Miscellaneous Circuits

The signal from the DS2 output amplifier is still in unipolar format. After the cable simulators, the signal is buffered by emitter follower Q11, and its associated components, which has an output impedance of 110 ohms. Q11

drives transformer T6 which converts the single-ended emitter follower output into a balanced 110 ohm source.

During a Reduce Level test, the voltage supplying each amplifier for DS1 and DS1C operation is reduced by Darlington amplifier Q12 and its associated components to a value that results in an output decrease of 24 dB. This level is adjustable by R85. During a reduce level test on DS2, relay K2 is energized to place in series with the output signal, a balanced, resistive Pi network, consisting of R76, R77, R78 and R79, which attenuates the output signal by 40 dB while maintaining the 110 ohm impedance.

B. DATA GENERATOR PCB ASSEMBLY (A2)

General. A block diagram of the Data Generator circuits is shown in Figure 4.11. The following descriptions identify the circuits in sections as shown in the block diagram. The Data Generator schematic is shown in Figure 7.6.

1. Clock Circuits

Three temperature compensated crystal oscillators (U1, U2, U3) produce frequencies of 6.176 MHz, 6.304 MHz, and 6.312 MHz. The 6.176 MHz from U1 is divided by four by U4A to produce the 1.544 MHz DS1 rate. The 6.304 MHz from U2 is divided by two by U4B to produce the 3.152 MHz DS1C rate. The 6.312 MHz output of U3 is used directly for DS2. A differential amplifier (Q1 & Q2) is used to isolate and allow a wide range of both amplitude and frequency of an external clock signal. The DS1, DS1C, DS2 and external clock lines are input to a 1-of-4 selector (U7A) which selects the clock which will run the Data Pattern Generator. Normally, data is generated at the DS1 rate. Clock selection is provided for unframed operation. For framed DS1 operation, the 1.544 MHz clock is sent to the DS1 Framing PCB where the clock is gapped at the DS1 framing bit locations. In unframed DS1 operation, the clock is fed back without gapping if the DS1 Framing PCB is installed. If the DS1 FRAMING PCB is not installed, jumper J7 is used to feed back the clock. In unframed DS1C or DS2 operation, the data is generated at the DS1C or DS2 rate and output di-

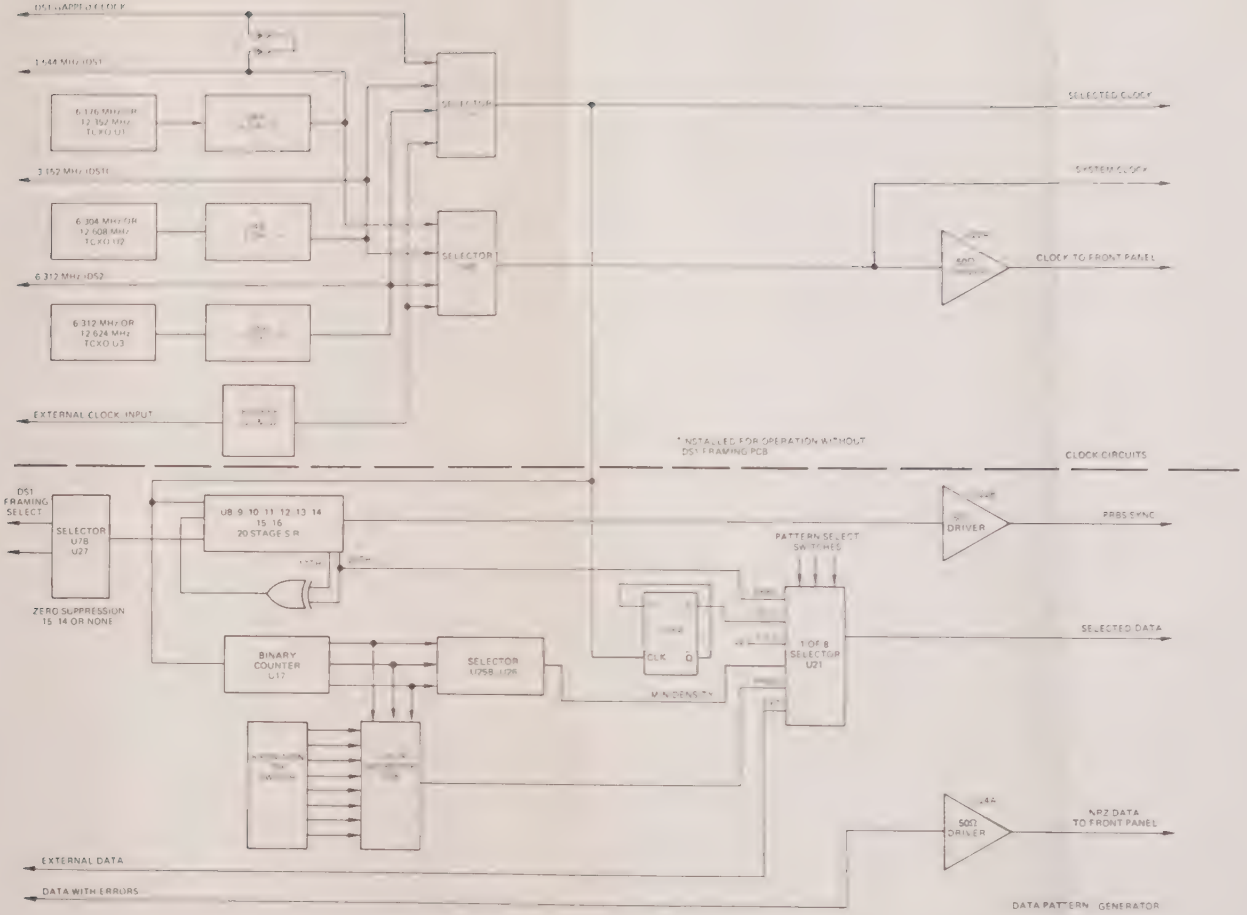


Figure 4.11. Data Generator PCB (A2), Block Diagram

rectly at that rate with no multiplexing or framing. If an external clock is used, the data will be output at the external clock rate with no multiplexing or framing.

2. Data Pattern Generator

The pseudo-random bit sequence (PRBS) pattern is generated by three 8-bit shift registers, U8, U9, U10 that form a 20-stage shift register. The output of stages 17 and 20 are Exclusive-ORed by U11B and fed back into stage 1. This generates a PRBS pattern that is $2^{20}-1$ (1,048,575) bits long. In this type of circuit, the all zeros state is a "hang-up" state and provisions are made with J-K flip-flop U23 so that if a hang-up occurs, U23 will insert "ones" after the occurrence of two framing bit timing pulses (49 or 53 bits apart) without the occurrence of a logic 1. The gates U12, U13, U14, U15, and selectors U7B and U27 form a zero suppression circuit. The circuit can perform 15, 14, or no zero suppression. When the DS1 data is framed, 14 zero suppression is performed. This is to prevent an excess zero condition which would result if a zero framing bit followed a string of 15 zeros. If the DS1 is unframed, 15 zero suppression is used. The zero suppression circuitry can be manually disabled by moving the jumper on J1 from pins 1 and 2 to pins 2 and 3. The output of U15B substitutes a "one" in place of the 15th and/or 14th zero, thus not allowing strings of many zeros. The PRBS Sync pulse is synchronized to the clock by U16B to remove glitches from the gate.

In addition to the PRBS pattern, a number of short data patterns can be generated and output from the Model 4653A transmitter. Any 8-bit pattern can be set on Dip Switch U20. This pattern is output bit-by-bit by the 1 of 8 selector U18, which is controlled by the binary counter U17. A minimum density pattern, consisting of: 1) unframed DS1, 1 "one" and 15 "zeros", 2) for framed DS1, 2 "ones" and 14 "zeros". The pattern is generated by counter U17 driving selector U26 which produces the appropriate pattern depending on whether DS1 Framing is enabled. An "all ones" pattern is generated by simply tying the data line to +5V. An alternate ones and zeros pattern (1010...) is generated by toggling the flip-flop U16A with the system clock. An external data pattern can be input through the front panel BNC connector. All of these

data patterns are fed to a 1-of-8 selector U21 which outputs the data pattern that has been selected by the front panel switches.

The Data Generator PCB also contains line drivers which provide a clock signal (U22A), data output (U24A) and PRBS sync pulse (U22B) to the appropriate BNC connectors on the front panel.

C. MULTIPLEXER PCB ASSEMBLY (A3)

General. A block diagram of the Multiplexer circuits is shown in Figure 4.12. The following descriptions identify the circuits in sections as shown in the block diagram. The Multiplexer schematic is shown in Figure 7.8. The Multiplexer provides the basic function of multiplexing 2 or 4 DS1 signals and adds framing bits to form the DS1C or DS2 signals respectively. For DS1C, channel 2 is a time slot delayed, inverted version of channel 1. For DS2, channel 1 and 2 are the same as DS1C with channel 3 being a time slot delayed, inverted channel 2 and channel 4 a delayed, inverted channel 3.

1. Bit Counters

4-Bit counters U1 and U2 form a divide by 53 (for DS1C) or 49 (for DS2) as controlled by the DS1C/DS2 select line. This select line also selects the DS1C or DS2 clock rate through 1-of-2 selector, U8A. The counters U1 and U2 are set to a number 48 or 52 counts below terminal count. When the counters reach terminal count, the Ripple Carry Output (RCO) of U2, switches high. Using the synchronous load input on the next clock cycle, the counters are again loaded 48 or 52 counts low and the cycle repeats. During the RCO active state, a framing bit will be selected by the multiplexer and, at all other times, data bits will be output. The RCO of U2 is also inverted by U23A and gated with the selected clock by U20A to produce a "gapped clock," which is the selected clock with a cycle missing during a framing bit interval. The channel clock decoder, U3A, is fed two address lines from the counter U1 and the gapped clock, and outputs pulses in channel sequence during the time interval when that channel's data is being sent.

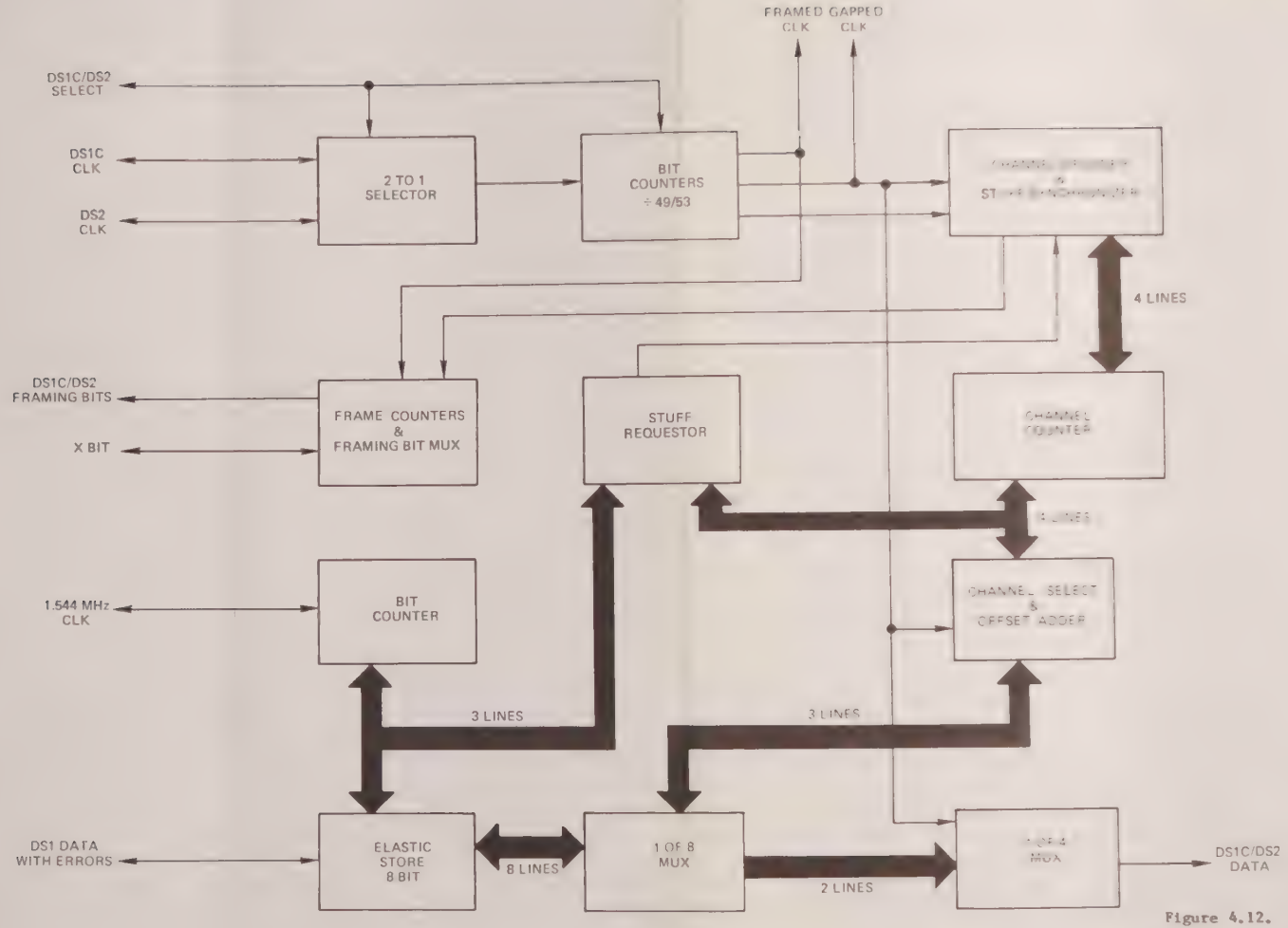


Figure 4.12. Multiplexer PCB (A3), Block Diagram

2. Elastic Store

The elastic storage is required because the sampling rate of a DS1C or DS2 signal is slightly faster than twice or four times as fast as a DS1 signal. This storage guarantees that no DS1 channel bits are lost. Occasionally, however, a bit will have to be repeated since the DS1C or DS2 clocks are not synchronously related. The DS1 data is loaded in an 8-bit addressable latch, U16, in sequence in address locations 0-7, 0-7,... The address is selected by counter U11B counting the DS1 clock and its three outputs and also selecting the location the data bit will be loaded into. The eight outputs of the latch U16 are asynchronously read by the 1-of-8 multiplexer U17 and multiplexed to form the DS1C or DS2 signals by the 1-of-4 multiplexer U14B. The outputs of counter U11B indicate the current bit being addressed and loaded.

3. Stuff Requestor

Just as there is a 3-bit address indicating the current bit being loaded, there is a 3-bit address indicating which bit is being read. The stuff requestor, a 4-bit magnitude comparator, U18, compares the load address with the read address. If they are equal, the stuff requestor output (A=B) will go high. The actual address being read for the channels is offset 1 bit behind the address being supplied to the stuff requestor to avoid a race condition of reading and loading the same bit.

4. Channel Counter and Offset Adder

Counter U11A is a 3-stage counter which addresses the channel 1 being sent and is reference for channels 2, 3,and 4. The bit which is sent from U17 is U11A plus an offset representing the channel. U11A changes only on channel 1. The offset addresses a number in U17 which is normally two bits behind U11B for channel 1, three bits for channel 2, four bits for channel 3, and five bits for channel 4. This makes channel 2 a one-bit delayed channel 1, channel 3 a one-bit delayed channel 2, and channel 4 a one-bit delayed channel 3. U11A is clocked at a greater rate than U11B so that at some point in time, U11A will equal U11B. This will request a stuff to be executed.

When a stuff is to be executed, the procedure must start in subframe one. At the set of data bits one position before the stuff locations, the clock of U11B is gapped and flip-flops U12A, U12B, and U13A are set. This produces a repeat in the channel 1 bit but allows normal output of the other channels. At this point, the bit being sent for channel 1 from U17 is two bits behind U11B while channels 2, 3, and 4 are only one bit behind U11B. As each stuff minus 1 position is reached in each subframe, the proper flip-flop will be reset which will produce a repeat of a bit in the stuffing position. After stuffing, that channel will be two bits behind U11B. The output of U17 is selected by U14B to be non-inverted or inverted. The coding is set up such that channels 1 and 3 are non-inverted while channels 2 and 4 are inverted.

5. Stuff Synchronizer

The stuff synchronizer performs the function of synchronizing the stuff request to the stuff time slot assigned for each channel in the subframe and M-Frame structures. The D flip-flop U5A is clocked by the channel 1 clock with the D input being the stuff request output from U18. When a stuff request occurs, it is latched into the D flip-flop. The flip-flop will only reset when the stuffing actually occurs. The second D flip-flop U5B is clocked by a "start of M-Frame" clock so that the request can be inserted in the three C-bit locations before the stuffing actually occurs. That is, the three C-bits are changed to "ones" during a stuff request. The D flip-flop U5B output is inserted in the C-bit location for the corresponding channel by U26.

6. Stuffing Location Gating and Insert

Gates U9A, U9B, U9D, U24D, U23D, U21A, U8B, U28 and U21B decode the stuffing locations. U21B produces a high level output when the bit positions one bit prior to the actual stuffing location are reached. The stuff location minus 1 output of U21B is gated with the synchronized stuffing request from U20C. A low output at U20C enables decoder U3B to gap counter U11A and control offset flip-flops U12A, U12B, and U13A. This produces a repeat of data bits in the proper position of the proper subframe for the channel in question.

7. Frame Counters and Framing Bit Multiplexer

The frame counters U4 and U13B count 6 resets of the bit counters to form a subframe and 4 subframes to form the M-Frame. DS1C and DS2 both consist of 6 information blocks per subframe and 4 subframes per M-Frame. Counter U4 counts through 6 states with these states selecting the framing bits through the 1-of-8 selector U26. Selector U10A, controlled by the subframe count, selects M-bits which follow the pattern 011X. (The X-bit is a "1" unless the front panel button is depressed to change it to a "0".) This is the I0 input to U26. I1, I3, and I5 are C-bit inputs and I2 and I6 are the F bits, 0 and 1.

D. DS1 FRAMING PCB (A4)

General. A block diagram of the DS1 Framing circuits is shown in Figure 4.13. The schematic is shown in Figure 7.10. The DS1 Framing circuits insert DS1 Framing bits into the data stream and also generate a DS1 gapped clock used to run the Data Generator circuits.

1. DS1 Framing Bits Insert

The DS1 rate data is input in serial form after it passes through the Bit Error Insertion circuitry. The framing sequence and position are controlled by U1; a T-1 Serial Transmitter IC. The data is converted from serial to parallel by U2 and latched by U9 in order to meet the set-up requirements of U1. U1 outputs framed DS1 data from its Binary Output pin (10). The data is resynchronized by U7 and applied to the 1 of 8 selector U6. Selector U5A allows either framed or unframed DS1 data to be sent to the Multiplexer PCB (A3) to be multiplexed up to DS1C or DS2. Jumper P2 on J1 is used to control the type of data sent to the Multiplexer. If P2 is on pins 1 and 2, framed data is sent to the Multiplexer. If the jumper is on pins 2 and 3, unframed data is always sent to the Multiplexer. In the DS1 mode, the Front Panel FRAME switch controls whether DS1 framing is inserted or not.

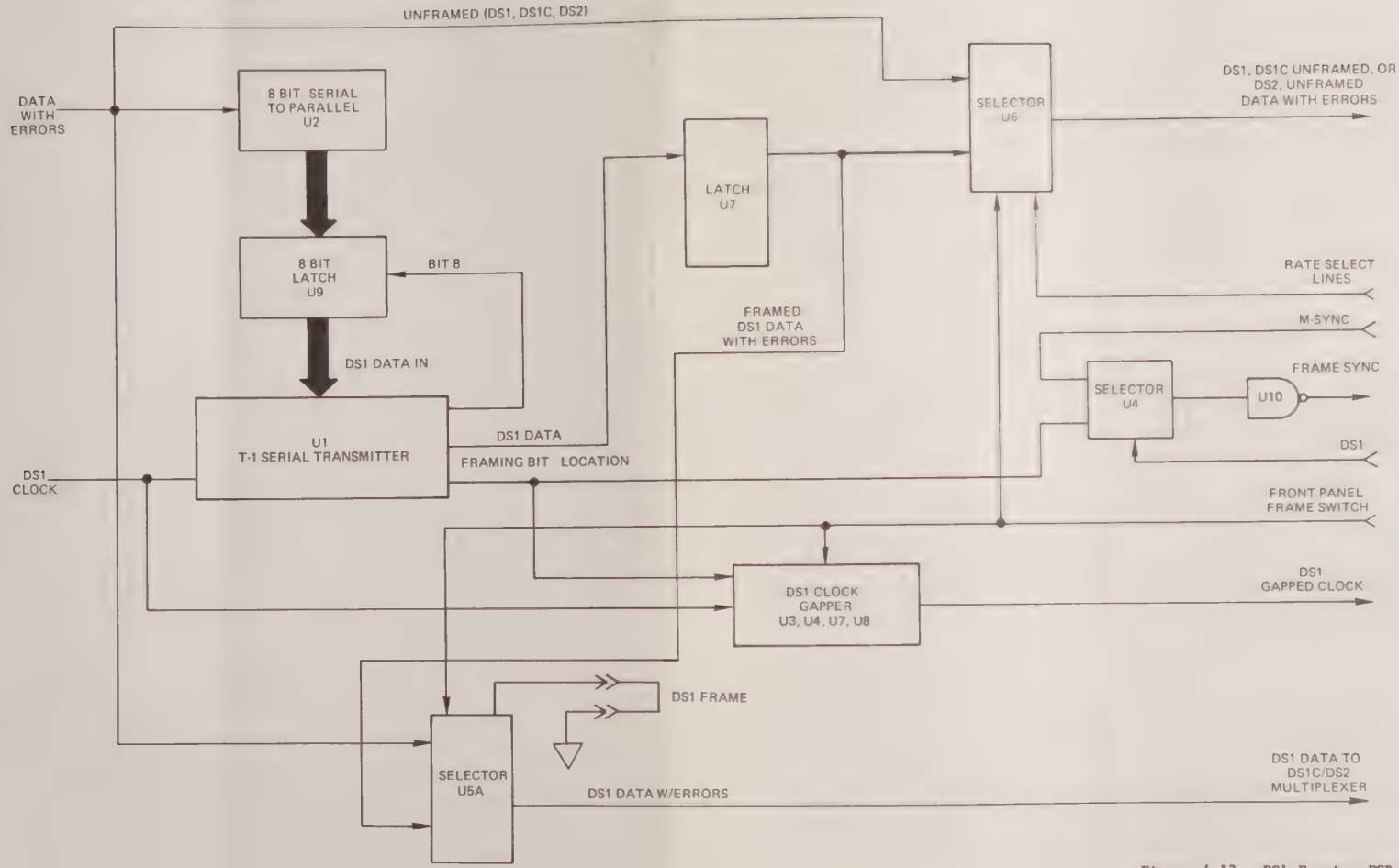


Figure 4.13. DS1 Framing PCB (A4), Block Diagram

2. Gapped Clock Generator

In some modes of operation, the data is generated at DS1 rate. However, when the DS1 is framed, the data generator must not be incremented during the insertion of a framing bit or a data bit will be lost. When the DS1 framed operation is selected, the DS1 clock is gapped in the framing bit locations. The circuit formed by U3A, U3B, U4A, U4B, U7B, U8A, U8B, U8C, C8, R2, and R3 perform the gapping operation when the T-1 Serial Transmitter IC (U1) indicates a DS1 framing location is coming up.

E. ERROR COUNT/INSERT PCB (A5)

General. A block diagram of the Error Count/Insert circuits is shown in Figure 4.14. The Error Count/Insert schematic is shown in Figure 7.12. The Error Count/Insert circuitry performs the function of counting data clock cycles for error insertion, performs Modulo-2 Scrambling of the DS1C data and the B6ZS encoding of the DS2 data. The following descriptions identify the circuits in sections as shown in the block diagram.

1. Error Counter

The Error Counter chain (U1, U2, U3, U4, and U5) forms the counter necessary to divide by $K \times 10^{-Y}$ where K is the mantissa set on the Front Panel Auto Rate thumbwheel and has integer values from 0 to 9, and Y is the exponent and has values of 3 to 9. The rate multiplier U1 multiplies by 0, 0.1, 0.2, ..., 0.9, that is, for each ten input pulses, U1 will output 0 to 9 pulses depending on the setting of the thumbwheel mantissa. The output from U1 is divided by 100 by the dual decade counter U2. The output of U2 is fed to six cascaded "divide-by-10" counters (U3, U4, and U5). The output of U2 and each "divide-by-10 counter" is fed to a 1-of-8 selector U6, whose output depends on the thumbwheel switch exponent. For example, if 7×10^{-6} is the selected error rate, then 7 errors must be inserted every million data bits. The rate multiplier (U1) set to seven outputs seven pulses for every ten input pulses which gives 7×10^{5} output pulse for every million input pulses. If 7×10^{5} is

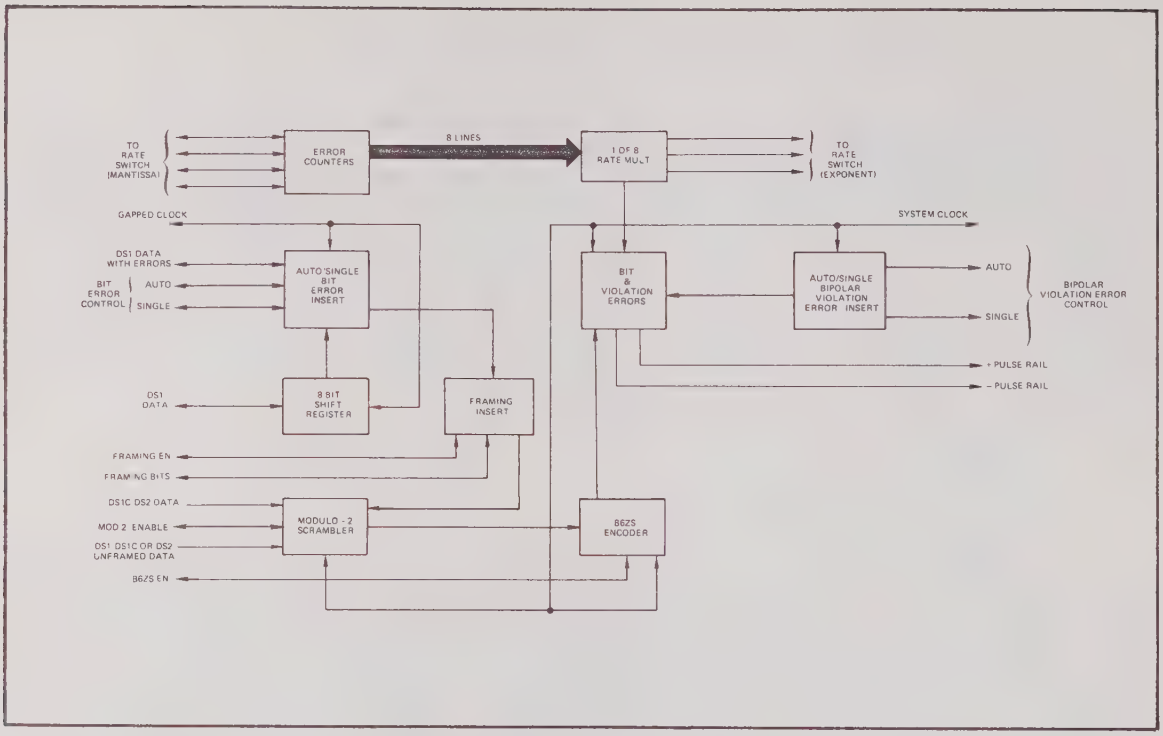


Figure 4.14. Error Count/Insert PCB (A4), Block Diagram

divided by 10^5, seven output pulses will occur per million clock cycles. Similarly, U6 can select other exponents. Output of the 1-of-8 selector (U6), is a square wave at the selected error rate. The output of U6 is differentiated by C3, R3 and part of U26 to change the square wave output to a string of short pulses. Although the Rate Multiplier (U1) does not divide with evenly spaced output pulses, the cascade of divide-by-10 counters will smooth this effect, so that error locations will remain within one clock cycle of their correct location.

2. Modulo - 2 Scrambler

The D flip-flop, U10A, stores the last data bit sent. This bit is exclusive-ORed with the incoming data bit by U20A to form the next data bit sent. Modulo-2 scrambling is done only on DS1C data bits. For DS1 and DS2, the scrambler is disabled by continuously clearing the D flip-flop.

3. B6ZS Encoder

The encoder circuitry (U14, U15, U17, U23) substitutes strings of 6 zeros with a OVBOVB code, where V is 1 pulse violating the last 1 and B is a 1 pulse not violating the last 1. The data is loaded into a shift register (U14, U15). When six "0's" are detected, the shift register is parallel loaded with a 011011 data pattern and a "divide-by-6" counter (U25) is started which inserts violations in the 2nd and 5th time locations during the substitution. B6ZS can occur on data or framing bits. The data selected by U8A is loaded into U14 and U15 shift registers. Gates U17 and U23 detect the 6 zeros in the first 6 locations. This is fed back to the set inputs of the shift registers to enable parallel data entry on the next clock cycle. Observe that the normal input bit is the parallel input bit to the first stage, so that a data bit will not be lost during the parallel load. The 6 zero detect also is parallel load enable to counter U25, which will be set to 9 and count back to 15. The counter outputs control to the 1 of 8 selector (U16) with its inputs coded to insert violations by stopping AMI toggle flip-flop (U9A) from toggling at bits 2 and 5. Once U25 reaches 15 (all ones), it hangs up again and substitution is complete.

4. Bit Error Insert

Errors are inserted in such a fashion so as to not exceed the 15 zero constraint and such that there be an equal likelihood of inserting a 0-to-1 or a 1-to-0 error and that errors not be inserted after B6ZS encoding. To avoid violating the 15 zero constraint, it is necessary to know if there is a data 1 preceding and following the data bit which is to be inverted. Data is loaded into an 8-bit shift register (U12) taking the output from the 5th stage - 3 following and 4 preceding, plus the next input bit. Then if there is at least one or more data ones following and preceding, error insertion is permitted. Data is inverted (U24C) and loaded into U12. The output of gates U18A and U18B will be a 1 if there is one or more input data "1's" preceding and following U12-6 output. Output of U19-3 is a logic 1 when it is OK to insert an error. This signal gates with the Error Request to form the J input to U13B. U13 employs feedback in order to force completion of the error insert cycle to

avoid inserting multiple errors. Errors are inserted by exclusive-OR gate U20B. The data stream with errors is fed back to the multiplexer circuitry.

5. AMI and BPV Insert

The J-K flip-flop U9A toggles with each data one. The output of U9A then selects + or - pulse output by gating with the data bit itself and the data clock. BPV errors can be inserted by keeping U9A from toggling when a data 1 occurs. This will then cause successive + or - data one pulses. J-K flip-flop (U7), synchronizes code violations with B6ZS encoding so that coding violations will not alter the B6ZS pattern. The data ones are gated with B6ZS "substituting" U25 carry out line to stop U7 from gating during substitution. Observe that the U7 output to insert violation is gated through U16 pin 12 multiplexer so that if a violation insert is started by U7 on the first cycle and a B6ZS occurs before the next data one cycle, multiple code violations during B6ZS will not be inserted.

F. INTERFACE PCB ASSEMBLY (A6)

General. A block diagram of the Interface circuits is shown in Figure 4.15. The Interface schematic is shown in Figure 7.14. The following descriptions identify the circuits in sections as shown in the block diagram. The circuitry located on the Interface PCB connects the Front Panel controls to the processing circuitry through the Motherboard. Several control signals feed straight through the Interface PCB to the Motherboard.

1. DS2 Select

The DS2 select circuit consists of a 3-input AND gate (U2A) and Exclusive-OR gate U4D. The AND gate output is a "0" when DS2-HI, DSX, or LO is selected by the Front Panel switches and the output is a "1" for all other cases. The Exclusive-OR gate U4D is used to invert the output of U2A for the proper sense to control the B6ZS enable.

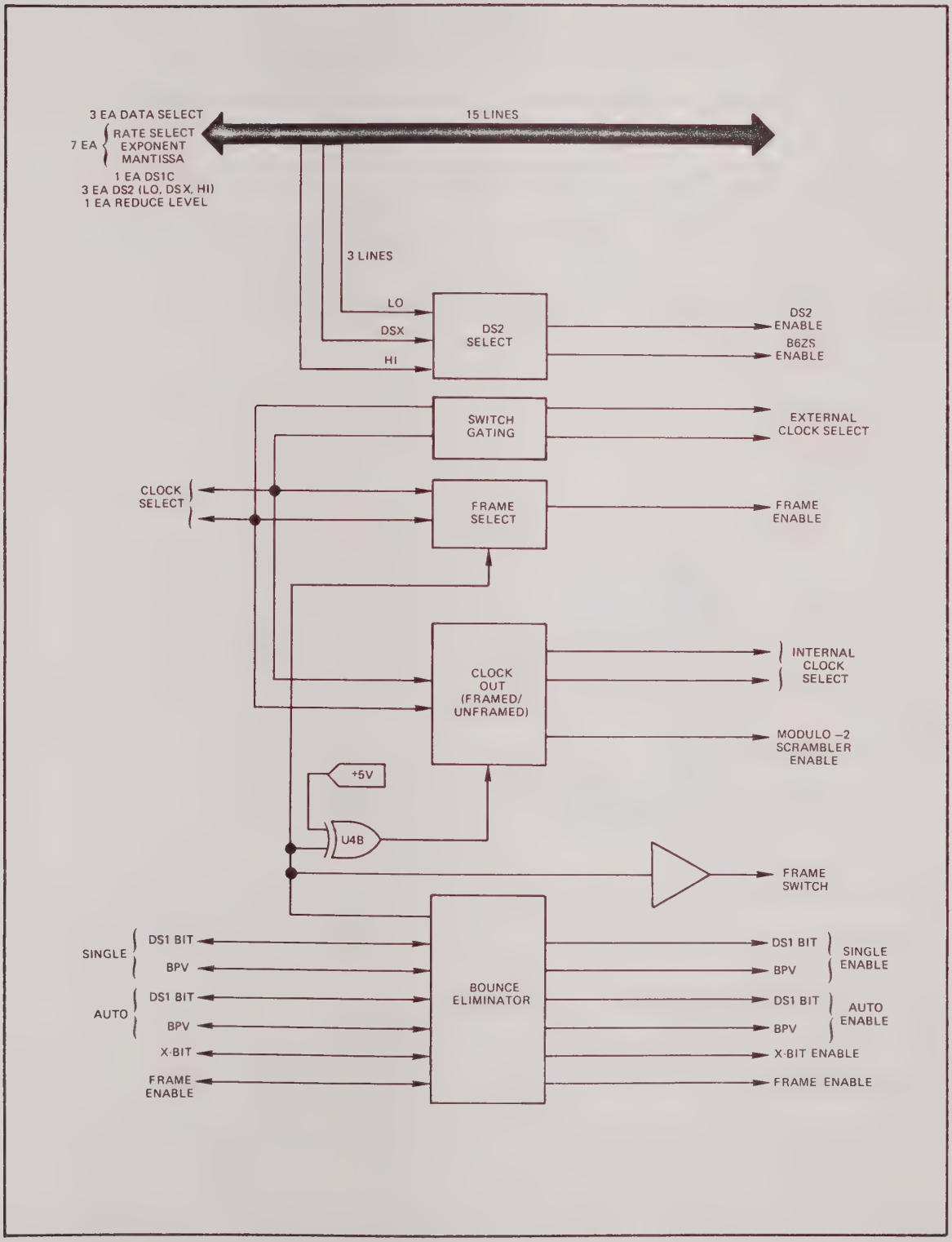


Figure 4.15. Interface PCB (A6), Block Diagram

2. Frame Select

The frame select consists of Exclusive-OR gate U4C and 2-Input NAND gates, U6A and U6B. The two clock select lines are fed into U4C, which gives an output of "0" for DS1 and external clocks and an output of "1" for DS1C and DS2 clocks. The output is NANDed by U6B with the inverted (U6A) frame select signal. The output of U6B then controls the framing. For DS1 and external clocks, there will be no framing. For DS1C and DS2 clocks, framing can be enabled or disabled by the FRAMING DS1C/2 switch on the front panel. The output of U6B is a "1" for framing disabled and a "0" for framing enabled.

3. Clock Out

The clock out circuitry consists of 3-input AND gates U2B and U2C, Exclusive-OR gates U4A and U4B and data selector U5. The two clock select lines and the frame select line are used to generate a proper clock selection sequence during framed or unframed operation. When unframed, a DS1, DS1C, DS2, or an external clock is selected as per front panel control settings. When running in framed mode (FRAMING switch ON, EXT CLOCK switch OFF), a DS1 clock rate is selected for DS1, DS1C, and DS2 operation. If the external clock is selected (EXT CLOCK switch ON and an external clock signal is connected), it becomes the clock in all cases.

4. Bounce Eliminator

The bounce eliminator (U3) prevents switch bounces from causing false triggering of signals or errors on the six control lines coming from the front panel. These are the Single and Auto DS1 Bit and BPV error switches, the Framing DS1C/2 switch, and the X-Bit switch.

CHAPTER 5
MAINTENANCE

5.1 GENERAL

Due to the reliability and nature of the Model 4653A Transmitter, frequent maintenance and alignment is not necessary. We do recommend, however, all units be inspected and calibrated yearly by Scientific-Atlanta personnel. This action insures that the equipment will meet the published specifications and provide you with trouble-free, accurate performance. Call your nearest Scientific-Atlanta representative or Regional Service Center to arrange for factory calibration. These are listed on the last page of this chapter.

WARNING

MAINTENANCE OR SERVICE TO THIS EQUIPMENT MUST BE PERFORMED ONLY BY TRAINED SERVICE PERSONNEL WHO ARE AWARE OF THE HAZARDS INVOLVED, SUCH AS FIRE AND ELECTRICAL SHOCK. WHEN SERVICE CAN BE PERFORMED WITHOUT POWER APPLIED, REMOVE ALL POWER.

UPON COMPLETION OF SERVICING, BE SURE THAT ALL SAFETY FEATURES ARE INTACT AND FUNCTIONING AND THAT PROTECTIVE GROUNDING HAS BEEN CONNECTED.

5.2 TROUBLESHOOTING

The intent of this section is to enable the technician to repair equipment out of warranty by locating and identifying defective printed circuit boards. Once the defective printed circuit board has been isolated, either a pre-tested replacement unit may be obtained from Scientific-Atlanta or further troubleshooting may be performed. It is suggested that prior to troubleshooting within a printed circuit board that the technician review thoroughly the applicable section in the Theory of Operation, Chapter 4, and the appropriate schematic.

Signals generated by the Model 4653A Transmitter are identified on the schematic and can be traced through circuits using appropriate test equipment. While it is not possible to describe all the failure modes associated with a Model 4653A Transmitter operating into a system, there are basic steps which can be performed to locate and isolate malfunctions. This chapter is arranged to provide a logical sequence of basic procedures to isolate a fault within a Model 4653A.

The recommended tests should be performed and verified using a Hewlett-Packard Model 3465A Digital Volt Meter (DVM) for voltage and resistance measurements and a Tektronix Model 475 Oscilloscope to observe waveform patterns, and a Hewlett-Packard Model 5315A Frequency Period Counter for frequency measurements. The test equipment should be calibrated and operating within its specified accuracy. Equivalent or better test equipment may be substituted when required.

5.3 TROUBLESHOOTING THE MODEL 4653A TRANSMITTER

General. Figure 5.1 is a flow chart of step-test sequences to isolating a malfunction within a Model 4653A Transmitter. Obviously the malfunction symptoms will dictate which steps should be performed and which steps can be set aside as secondary or to be performed if the initial steps fail to isolate the malfunction. If a malfunction is isolated to a printed circuit board which can be field calibrated (i.e., a power source PCB), perform the entire calibration procedure before attempting to verify normal operation. If a malfunction is isolated to a source that does not respond to normal repair procedures and/or calibration, then the suspect source should be replaced by an identical item purchased from Scientific-Atlanta.

A. MODEL 4653A VISUAL INSPECTION

A visual inspection check of a Model 4653A Transmitter should consist of the following steps as a minimum:

a. Check all PCB's for proper installation and location.

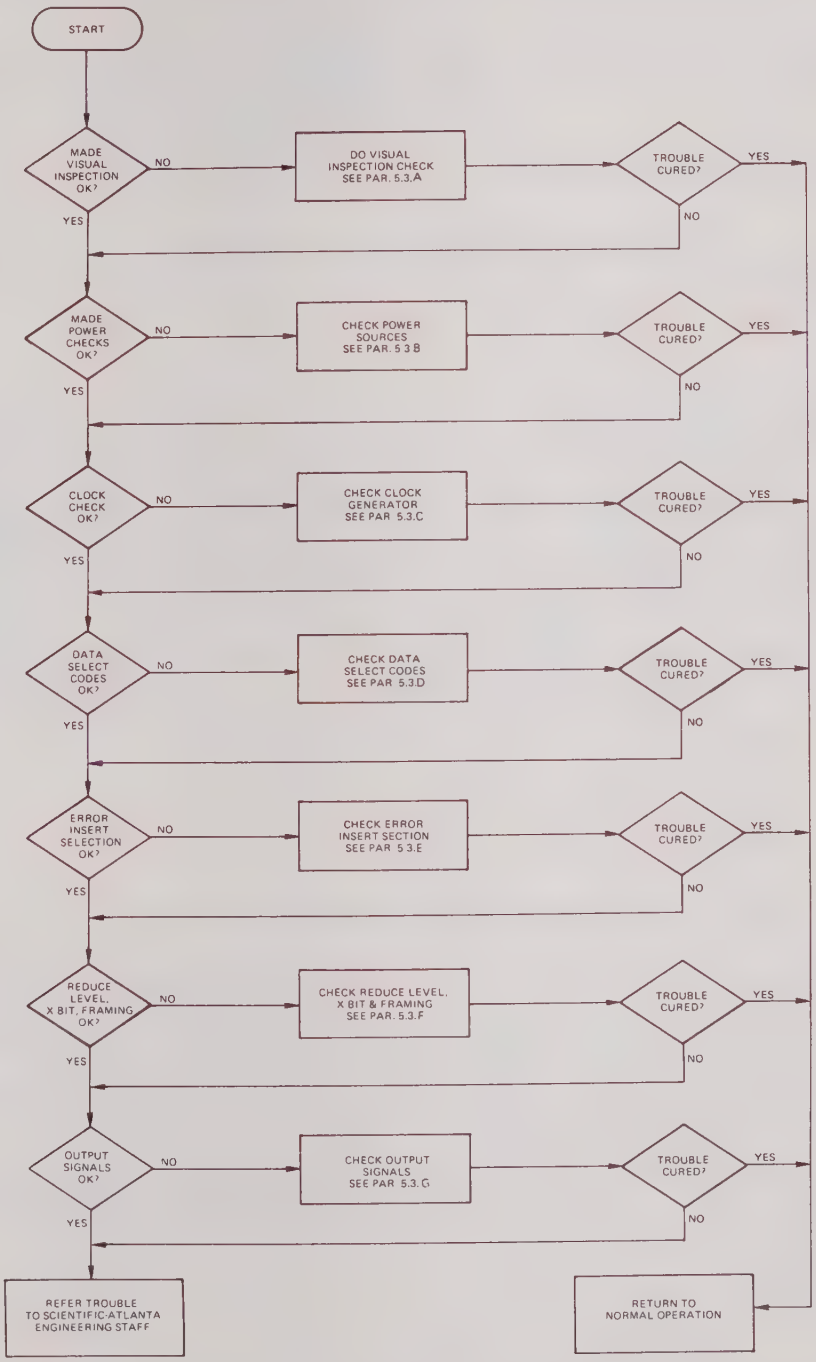


Figure 5-1. Troubleshooting Flow Chart

b. Check for broken wires. This includes all PCB connections, coax and flat cables, and panel connections. Observe PCB components for obvious defects, (i.e., discoloration, bulging, overheating).

c. Check all cables for proper installation. Inspect for bent pins, deformed connector shells, frayed or punctured insulation, etc.

B. MODEL 4653A POWER SOURCES

A check of the Model 4653A Transmitter power sources should be verified using the DVM and the following tests:

a. Check the ac input source (if used). Determine if the ac source is controlled by a switch. Check the source ac at the chassis connector. Verify that the voltage select PCB next to the ac fuse is properly installed. (See Figure 5.2). Check the ac fuse for continuity. Check ac distribution using schematic diagrams in Chapter 7. Verify the following requirements. If the requirements are not met, troubleshoot and repair the AC linear power supply PCB. (If unit contains this type of power supply).

On PCB A10, measure from TP-2 (COM) to TP-1.

Requirement: +5.00 (±0.25)V dc

On PCB A10, measure from TP-4 (COM) to TP-3.

Requirement: +12.00 (±0.1)V dc

On PCB A10, measure from TP-4 (COM) to TP-6.

Requirement: -12.00 (±0.1)V dc

On PCB A10, measure from TP-4 (COM) to TP-5.

Requirement: -5.00 (±0.25)V dc

b. Check the DC Input source (if used). Determine if the dc source is connected using the correct polarity. Check the dc fuses on the Rectifier and Filter Assembly PCB (A13A1) for continuity. Check the input dc source distribution using schematic diagrams in Chapter 7.

c. Check the operation of the -5.2V/-12V Power Supply PCB (A10) and the +5V/+12V Power Supply PCB (A11). Verify the following requirements. If the requirements are not as shown, then troubleshoot and repair the power supply PCBs.

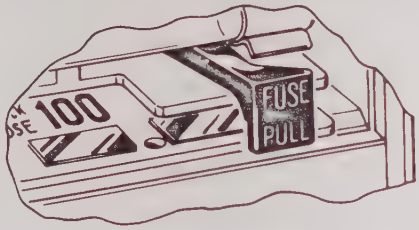
On PCB A10, measure from J1-3 to J1-1.

Requirement: -5.2 (±0.3)V dc

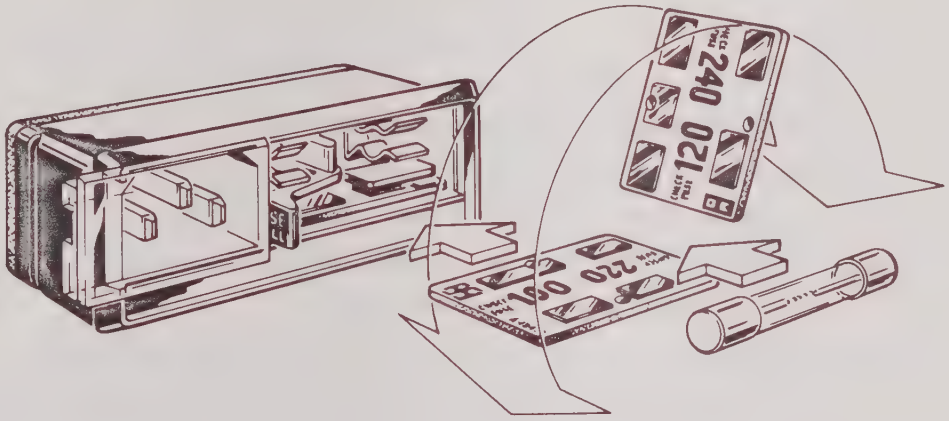
On PCB A10, measure from J1-3 to J1-9.

Requirement: -12(±0.4)V dc

On PCB A11, measure from J1-1 to J1-5.



Operating voltage is shown through the sliding plastic window.



HOW TO SELECT OPERATING VOLTAGE

1. Remove the ac power cord connector.
2. Slide the plastic window to the left.
3. Carefully operate FUSE PULL tab to the left.
4. Carefully remove both the fuse and printed circuit board. A small hole is provided to accommodate a wire pull if necessary.
5. Correctly orient the printed circuit board so the desired voltage is located on the top left side.
6. Carefully return the printed circuit board to the original location. Be sure it is securely seated.
7. Return FUSE PULL tab to the normal position.
8. Replace the original fuse with one selected for correct fuse value.

Illustrations courtesy of Corcom Corp., Chicago, Ill.

Figure 5-2. Selecting the Proper Operating Voltage

Requirement: +12 (±0.4)V dc

On PCB A11, measure from J1-3 to J1-5.

Requirement: +5.1 (±0.1)V dc

C. MODEL 4653A INTERNAL CLOCKS/EXTERNAL CLOCK

A check of the internal clocks should be verified using the Hewlett-Packard Model 5315A Frequency Counter connected to Output Clock (BNC) on Front Panel. Verify the following requirements. If the requirements are not met, troubleshoot and repair the Data Generator PCB (A2).

a. Internal Clocks:

With OUTPUT SELECT switch in the DS1 position.

Requirement: 1.544 MHz (±10 Hz)

With OUTPUT SELECT switch in the DS1C position.

Requirement: 3.152 MHz (±10 Hz)

With OUTPUT SELECT switch in the DS2 position.

Requirement: 6.312 MHz (±10 Hz)

b. External Clock:

With an External Clock signal connected to the INPUT CLOCK connector (BNC located on the Front Panel). Range of 500 KHz to 10 MHz.

With EXT CLOCK switch in the ON position.

Requirement: Will read the External Clock signal Frequency.

D. MODEL 4653A DATA SELECT CODES

A check of the Data Select Codes should be verified using the Oscilloscope connected to the OUTPUT DATA connector (BNC) located on the Front Panel. The OUTPUT SELECT switch should be in the DS1 position. Check the circuit description in chapter 4 and the schematic diagrams in Chapter 7. Verify the following requirements. If the requirements are not met, troubleshoot and repair the Data Generator PCB (A2).

With DATA switch in the PRBS position.

Requirement: A 1,048,575 Random Bit Sequence

With DATA switch in the MIN DENSITY position.

Requirement: A sequence of a one and fifteen zeros.

With DATA switch in the 1111 position.

Requirement: All ones Sequence

With DATA switch in the 1010 position.

Requirement: Alternating ones and zeros

With DATA switch in the EXT position.

Requirement: Bit Sequence as input to INPUT DATA connector (BNC)

With DATA switch in the PROG position.

Requirement: 8-Bit Sequence as programmed in dip switch U20

E. MODEL 4653A ERROR INSERT SELECTION

A check of the Model 4653A Transmitter Front Panel ERROR INSERT select function should be verified using the DVM for continuity checks and the Oscilloscope for signal tracing when performing the following tests. Check the schematic diagrams in Chapter 7 and circuit description in Chapter 4.

a. SINGLE ERROR DATA BIT. Check the switch operation while observing the input to A6U3-14. Also check the output of A6U3-2.

b. SINGLE ERROR BIPOLAR VIOLATION (BPV). Check the switch operation while observing the input to A6U3-1. Also check the output of A6U3-15.

c. BIT ERROR RATE. Check switch inputs to the Rate Multiplier A5U1 pins 2, 3, 14, 15 and to the 1-of-8 Selector A4U6 pins 9, 10, 11.

F. MODEL 4653A REDUCE LEVEL, X-BIT, AND FRAMING CONTROL

A check of the Model 4653A Transmitter Front Panel REDUCE LEVEL, X BIT, and FRAMING select functions should be verified using the DVM for voltage checks and the Oscilloscope for signal tracing when performing the following tests. Check the schematic diagrams in Chapter 7 and circuit description in Chapter 4.

a. REDUCE LEVEL. Check switch inputs to the Buffer Amplifier A1U3 pins 1 and 5. Also check the output of A1U3 pins 2 and 6.

b. X BIT. Check switch input to the M-Bit Multiplexer A3U10-3.

c. FRAMING. Check FRAMING switch input to the Switch Debouncer A6U3-12. Also check the output of A6U3-4.

G. MODEL 4653A OUTPUT SIGNAL SELECTION

A check of the Model 4653A Transmitter Front Panel OUTPUT DS1/DS1C/DS2 signal select function should be verified using the Oscilloscope connected to OUTPUT connectors (WE-310) as needed when performing the following tests. Check the schematic diagrams in Chapter 7 and circuit description in Chapter 4.

1. DS1 OUTPUT. With OUTPUT SELECT switch set to DS1, DATA switch set to 1111.

   Measure the output signal at DS1 output connector. (4 ea.)
   Requirement: Frequency Rate = 1.544Mb/s
   Amplitude = ±3.0 (±0.3)V peak bipolar
   Width = 324 (±30) ns
   Rise/Fall Time (10 to 90%) = 50 (±25) ns

2. DS1C OUTPUT. With OUTPUT SELECT switch set to DS1C, DATA switch set to 1111.

   Measure the output signal at DS1C output connector. (4 ea.)
   Requirement: Frequency Rate = 3.152Mb/s
   Amplitude = ±3.0 (±0.3)V peak bipolar
   Width = 159 (±30) ns
   Rise/Fall Time (20 to 80%) = 38 (±14) ns

3. DS2 HI OUTPUT. With OUTPUT SELECT switch set to DS2 HI, Data switch set to 1111.

   Measure the output signal at DS2 output connector. (1 ea.)
   Requirement: Frequency Rate = 6.312Mb/s
   Amplitude = ±2.1V (±1 dB) peak bipolar
   Pulse Width = 50% duty cycle

4. DS2 DSX OUTPUT. With OUTPUT SELECT switch set to DS2 DSX, DATA switch set to 1111.

   Measure the output signal at DS2 output connector. (1 ea.)
   Requirement: Frequency Rate = 6.312Mb/s
   Amplitude = HI output through simulated 1000' of 22 Ga. ABAM Cable.

5. DS2 LO OUTPUT. With OUTPUT SELECT switch set to DS2 LO, DATA switch set to 1111.

Measure the output signal at DS2 output connector. (1 ea.)
Requirement: Frequency Rate = 6.312Mb/s
Amplitude = HI output thru simulated 2000' of 22 Ga. ABAM Cable plus fixed 6 dB Attenuator.

5.4 CALIBRATION

General. The following procedure describes adjustments which can be accomplished under normal conditions in a general electronic repair center. Adjustments to power supplies are provided in the first procedure.

A. TEST EQUIPMENT

The test equipment or its equivalent listed in Table 5.1 is required to perform the tests in this procedure. All test equipment must be calibrated and operating within its specified accuracy.

Table 5.1
Test Equipment

Description	Model	QTY	Manufacturer
DVM	3465A	1	Hewlett-Packard
Oscilloscope	475	1	Tektronix
Frequency/Period Counter	5315A	1	Hewlett-Packard
Probe, FET	P6201	2	Tektronix
Probe, 1M Ohms	P6106	2	Tektronix
DC Supply, 0-60V,9A	DCR609B	1	Sorenson

B. AC SOURCE POWER SUPPLY CALIBRATION

Adjust the Power Supply in the unit operating under loaded conditions. The Power Supply PCB (A10) is accessible by removing the top cover. With the ac Power OFF, extract the PCB and lay it on top of the chassis with cables attached. Use insulating material such as cardboard for safety. Switch the ac power ON. There are two adjustments on the Power Supply PCB: the +12V and the -12V Power Supplies. The adjustments are made as follows:

a. +12V POWER SUPPLY. Connect the DVM to TP-3 and TP-4 (COM). Adjust Potentiometer R12 until DVM reads +12.00 (±0.1)V.

b. -12V POWER SUPPLY. Connect the DVM to TP-6 and TP-4 (COM). Adjust Potentiometer R18 until DVM reads -12.00 (±0.1)V.

C. DC SOURCE POWER SUPPLY CALIBRATION

The DC Source Power Supply consists of two sections: the -5.2/-12.0V section and the +5.0/+12.0V Section. Each section is adjusted separately as follows:

-5.2/-12.0V Power Supply. Adjust the -5.2/-12.0V Power Supply PCB in the unit operating under loaded conditions. Remove the ac source and apply a -22V dc source to the "DC POWER" connector. The PCB's are accessible by removing the top cover. With the external dc power source OFF, extract the power supply PCB and lay it on top of the chassis with cables attached. Use insulating material such as cardboard for safety. Switch the dc power source ON.

a. Connect the DVM to monitor the -12.0V dc output between J1-3 (COM) and J1-9. Adjust variable resistor R7 counterclockwise two turns from the point it last affects the measured -12.0V dc output.

b. Connect the DVM to monitor the -5.2V dc output between J1-3 (COM) and J1-1. Adjust variable resistor R30 counterclockwise two turns from the point it last affects the measured -5.2V dc output.

c. Adjust variable resistor R23 to set the -5.2V dc output to -5.25V dc.

d. Adjust variable resistor R30 slowly clockwise to the point the DVM indication starts to decrease. Then adjust R30 counterclockwise two turns from this point.

e. Connect the DVM to monitor the -12.0V outputs between J1-3 and J1-9. The DVM should indicate -12.0 (±0.3)V dc. Adjust variable resistor R7 clockwise until the -12.0V dc outputs start to decrease, then adjust R7 counterclockwise two turns from this point.

f. This completes adjustment of the -5.2V/-12.0V Power Supply section.

+5.0V/+12.0V Power Supply. Adjust the +5.0V/+12.0V Power Supply PCB in the unit operating under loaded conditions. Remove the ac source and apply a -22V dc source to the "DC POWER" connector. The PCB's are accessible by re-

moving the top cover. With the external power source OFF, extract the power supply PCB and lay it on top of the chassis with cables attached. Use insulating material such as cardboard for safety. Switch the dc power source ON.

a. Adjust variable resistors R1 and R17 three turns counterclockwise. Connect the DVM to monitor the +12.0V output between J1-5 (COM) and J1-1. Adjust variable resistor R4 until the DVM indicates +12.0 (±0.1)V dc.

b. Adjust variable resistor R1 slowly clockwise until the DVM indication starts to decrease, then adjust R1 slowly counterclockwise two turns.

c. Connect the DVM to monitor the +5.0V output between J1-5 (COM) and J1-3. Adjust variable resistor R20 slowly until the DVM indicates +5.1 (±0.1)V dc.

d. Adjust variable resistor R17 slowly clockwise until the DVM indication starts to decrease, then adjust R17 slowly counterclockwise two turns.

e. This completes the adjustment of the +5.0V/+12.0V Power Supply.

D. MODEL 4653A TRANSMITTER CALIBRATION

There are two other adjustments to make in the transmitter, the internal CLOCK and the REDUCE LEVEL adjustments. Make the adjustments as follows:

a. Internal Clock Adjustment

Make these three oscillator adjustments:

1. Connect the Frequency Counter to the OUTPUT CLOCK connector (BNC located on the Front Panel). Remove the top cover and place the DATA GENERATOR PCB (A2) on an extender card.

2. Place the OUTPUT SELECT switch in the DS2 position. Place the POWER switch ON.

3. Adjust the trimmer capacitor, C6, until frequency counter reads 6.312 MHz (±10 Hz).

4. Place the OUTPUT SELECT switch in the DS1C position, and adjust trimmer, C5, until the frequency counter reads 3.152 MHz (±10 Hz).

5. Place the OUTPUT SELECT switch in the DS1 position, and adjust trimmer, C4, until the frequency counter reads 1.544 MHz (±10 Hz).

b. Reduce Level Adjustment

The REDUCE LEVEL Adjustment is one adjustment for both the DS1 and DS1C functions. The level is fixed for DS2. This adjustment is located on OUTPUT AMPLIFIER PCB (A1).

1. Connect the Oscilloscope to the OUTPUT DS1/DS1C connector (WE-310) located on the Front Panel using a 110-ohm terminator. Place the OUTPUT AMPLIFIER PCB (A1) on an extender card. Turn Power ON.

2. Place the OUTPUT SELECT switch in the DS1 position. Place the DATA switch in the all one's position (1111). Place FRAMING DS1C/2 switch in the OUT position (no framing).

3. While holding the REDUCE LEVEL switch in the ON position, adjust variable resistor R85 until the waveform has a center-to-peak amplitude of 0.19(±0.02)V.

c. This completes the calibration section of the transmitter.

5.7 REGIONAL SERVICE CENTERS

Regional Service Centers capable of performing periodic maintenance and providing assistance associated with the Model 4653A Transmitter and other Scientific-Atlanta equipment are listed below. Service Assistance for areas not listed can be provided through the Scientific-Atlanta Field Service Center, 4025 Pleasantdale Road, Atlanta, Georgia 30340; TEL: 404-441-2184; TWX: 810-766-4912; TELEX: 0542898.

NORTH AMERICAN REGIONAL SERVICE CENTERS

Northeastern Regional Office
149 Middlesex Turnpike
Burlington, Massachusetts 01803
Tel: 617-272-1256

Washington D.C. Regional Office
Washington Business Park
5100-J Philadelphia Way
Tanham, Maryland 20706
Tel: 301-577-4830

Mid Atlanta Regional Office
2100 Route 208
Fair Lawn, New Jersey 07410
Tel: 201-791-8777

Southeastern Regional Office
4025 Pleasantdale Road
Atlanta, Georgia 30340
Tel: 404-449-2021

Florida Regional Office
P.O. Box 2143
841 West Emmett St.
Kissimmee, Florida 32741
Tel: 305-846-0055

Midwest Regional Office
Fidelity Bldg., Suite 306
11550 N. Meridian
Carmel, Indiana 46032
Tel: 317-846-7142

Chicago Service Center
621 East Butterfield Rd., Suite 219
Lombard, Illinois 60148
Tel: 312-963-6375

Southwestern Regional Office
1237 Executive Drive, East
Richardson, Texas 75081
Tel: 214-238-1116

Denver Service Center
103 Inverness Dr. East
Inglewood, Colorado 80112
Tel: 303-790-0585

So. California Regional Office
P.O. Box 2668
10039 Pioneer Boulevard
Santa Fe Springs, California 90670
Tel: 213-949-9411

No. California Regional Office
3375 Scott Boulevard, Suite 304
Santa Clara, California 95051
Tel: 408-496-1040

INTERNATIONAL SERVICE CENTERS

CANADA
Scientific-Atlanta, Ltd.
1640 Bonhill Road
Unit 6
Mississauga, Ontario L5T1C8
Tel: 416-677-6555
Telex: 06983600

GERMANY
Scientific-Atlanta GmbH
Albert Schweitzerstrasse 66/3
D8000 Munich 83, Germany
Tel: 49.8967.1044
Telex: 5212264

ENGLAND
Scientific-Atlanta, Ltd.
Horton Manor
Stanwell Road, Horton
Slough SL3 9PA, England
Tel: 44.2812-3211
Telex: 849406

ITALY
Scientific-Atlanta, S.p.A.
Via Benedetto Croce 19
00142 Rome, Italy
Tel: 39.06.5420244
Telex: 721441

FRANCE
Scientific-Atlanta S.A.
4 Avenue Gabriel Peri
78360 Montesson
France
Tel: 33.1.9769191
Telex: #46385

CHAPTER 6
PARTS LISTS

6.1 GENERAL

The parts lists for Model 4653A Error Rate Transmitter are included in this chapter. Special modifications, if any, are enclosed in the envelope in the rear of this manual.

6.2 EXPLANATION OF COLUMN HEADINGS

REF. DESIG. This identifies the assigned reference designation applicable to a system or equipment sub-unit having a separate prefix and arrangement of individual components.

PART NO. A five or six digit number assigned by Scientific-Atlanta to the specific part for identification and correct replacement ordering information.

DESCRIPTION. A brief electrical and/or mechanical description of the component.

FSCM CODE. The proper Federal Supply Code for Manufacturers is entered in this column. The code numbers are from the Federal Supply code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) in effect as of the publication date of this manual. Alphabetical codes have been arbitrarily assigned to suppliers not assigned in the H4 handbooks and these identifying codes are cross-referenced (code-to-name) at the end of this section.

VENDOR PART NO. The number assigned to a part by an outside supplying manufacturer is listed in this column.

6.3 ORDERING PARTS

When ordering parts from Scientific-Atlanta, always include the Scientific-Atlanta part number, the part description, the unit name, the unit serial number, the subassembly name, the part manufacturer (FSCM), and the manufacturer's part number.

6.4 PARTS SUBSTITUTION

Common components may differ from those identified in the parts list. This difference is due to the substitution of a more current part during assembly. When this occurs, the replacement may be either a part identical to the type removed or a part meeting the description given in the parts lists.

MODEL 4653A TEST SET TRANSMITTER

Comp Desig	S-A Part No.	Description	Page
A1	252713	Output Amplifier PCB Assembly	6-4
A2	304131	Data Generator PCB Assembly	6-7
A3	304174	Multiplexer PCB Assembly	6-9
A4	304128	DS1 Framing PCB Assembly	6-10
A5	304177	Error Count/Insert PCB Assembly	6-11
A6	304134	Front Panel Interface PCB Assembly	6-12
A9	304137	Motherboard PCB Assembly	6-13
*A10	252725	Power Supply PCB Assembly	6-14
**A10	220905	-5.2V/-12V Power Supply PCB Assembly	6-16
**A11	220917	+5.2V/+12V Power Supply PCB Assembly	6-19
A12	304122	Front Panel Assembly	6-21
A12A1	252722	Front Panel PCB Assembly	6-21
A12A2	252741	Flex Circuit Auto Rate Sw PCB Assembly	6-21
*A13	252735	Rear Panel Assembly	6-22
**A13	252745	Rear Panel Assembly	6-23
**A13A1	252781	Rectifier and Filter PCB Assembly	6-23
	*252751	Power Wiring Harness	6-24
	**220947	Power Wiring Harness	6-24
	304138	Accessory Kit	6-25
	304139	Service Accessory Kit	6-25

*AC Version Only.
**AC/DC Version Only.

TRANSMITTER OUTPUT AMPLIFIER PCB ASSEMBLY - 252713

REF DESIG PREFIX: 4653A-A1

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0070525	CAPACITR 150 PF 1KV CER DISC S3N 10%	71590	DD-151
C 2	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 3	0070525	CAPACITR 150 PF 1KV CER DISC S3N 10%	71590	DD-151
C 4	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 5	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 6	0070525	CAPACITR 150 PF 1KV CER DISC S3N 10%	71590	DD-151
C 7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 8	0070525	CAPACITR 150 PF 1KV CER DISC S3N 10%	71590	DD-151
C 9	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 10	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 11		NOT ASSIGNED		
C 12	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 14	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 15	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 16	0078600	NOT ASSIGNED		
C 17	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 18		NOT ASSIGNED		
C 19	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 20	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 21	0070525	CAPACITR 150 PF 1KV CER DISC S3N 10%	71590	DD-151
C 22	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 23	0070525	CAPACITR 150 PF 1KV CER DISC S3N 10%	71590	DD-151
C 23		NOT ASSIGNED		
C 24	0084972	CAPACITR .0013 MF 500V SILVER MICA 1%	53021	D195E132F03
C 25	0082395	CAPACITR .0012 MF 100V SILVER MICA 5%	53021	D151F122J03
C 26	0084972	CAPACITR .0013 MF 500V SILVER MICA 1%	53021	D195E132F03
C 27	0082395	CAPACITR .0012 MF 100V SILVER MICA 5%	53021	D151F122J03
C 28	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 29	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 30		NOT ASSIGNED		
C 31	0073494	CAPACITR 22 PF 500V SILVER MICA 5%	14655	CD15ED220J03
C 32	0075217	CAPACITR 10 MF 50V	80183	50CD10EG050CB7
C 33	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 34	0070671	CAPACITR 100 MF 25V	80183	5CCD107G025DD7
C 35	0070671	CAPACITR 100 MF 25V	80183	5CCD107G025DD7
CR 1	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR 2	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR 3	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR 4	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
K 1	0085285	RELAY 12VDC TO-5 PKG		732-12
K 2	0085285	RELAY 12VDC TO-5 PKG		732-12
K 3	0085285	RELAY 12VDC TO-5 PKG		732-12
K 4	0085285	RELAY 12VDC TO-5 PKG		732-12
L 1	0171530	INDUCTOR 33 UH SUBMIN SHLD ENCAP 5%		WEE-33
L 2	0171530	INDUCTOR 33 UH SUBMIN SHLD ENCAP 5%		WEE-33
L 3	0171530	INDUCTOR 33 UH SUBMIN SHLD ENCAP 5%		WEE-33
L 4	0171530	INDUCTOR 33 UH SUBMIN SHLD ENCAP 5%		WEE-33
L 5	0171529	INDUCTOR 7.1 UH SUBMIN UNSHLD 3%		IR-2
L 6	0171528	INDUCTOR 6.6 UH SUBMIN UNSHLD 3%		IR-2
L 7	0171529	INDUCTOR 7.1 UH SUBMIN UNSHLD 3%		IR-2
L 8	0171528	INDUCTOR 6.6 UH SUBMIN UNSHLD 3%		IR-2
Q 1	0085992	TRANSSTR 2N2905A PNP SIL		2N2905A
Q 2	0085992	TRANSSTR 2N2905A PNP SIL		2N2905A
Q 3	0085992	TRANSSTR 2N2905A PNP SIL		2N2905A
Q 4	0085992	TRANSSTR 2N2905A PNP SIL		2N2905A
Q 5	0085992	TRANSSTR 2N2905A PNP SIL		2N2905A
Q 6	0085992	TRANSSTR 2N2905A PNP SIL		2N2905A
Q 7	0085992	TRANSSTR 2N2905A PNP SIL		2N2905A
Q 8	0085992	TRANSSTR 2N2905A PNP SIL		2N2905A
Q 9	0085992	TRANSSTR 2N2905A PNP SIL		2N2905A
Q 10	0085992	TRANSSTR 2N2905A PNP SIL		2N2905A
Q 11	0078851	TRANSSTR 2N2219 NPN SIL	13715	2N2219
Q 12	0084113	TRANSSTR TIP 111 NPN SIL DARLINGTON PAIR	01295	TIP 111

TRANSMITTER OUTPUT AMPLIFIER PCB ASSEMBLY - 252713

REF DESIG PREFIX: 4653A-A1

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 1	0079125	RESISTOR 402 OHM RN55C 1% MTL FLM		RN55C402DF
R 2	0083876	RESISTOR 499 OHM RN55C 1% MTL FLM		RN55C4990F
R 3	0075589	RESISTOR 56 OHM 1W 10% COMP	01121	RCR32G560KS
R 4	0083876	RESISTOR 499 OHM RN55C 1% MTL FLM		RN55C4990F
R 5	0079125	RESISTOR 402 OHM RN55C 1% MTL FLM		RN55C402DF
R 6	0083856	RESISTOR 110 OHM RN55C 1% MTL FLM		RN55C1100F
R 7	0171527	RESISTOR 5.11 OHM 1/4W 1% MTL FLM		CMF-55C
R 8	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 9	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 10	0083891	RESISTOR 1.50K OHM RN55C 1% MTL FLM		RN55C1501F
R 11	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 12	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 13	0171527	RESISTOR 5.11 OHM 1/4W 1% MTL FLM		CMF-55C
R 14	0079125	RESISTOR 402 OHM RN55C 1% MTL FLM		RN55C402DF
R 15	0083876	RESISTOR 499 OHM RN55C 1% MTL FLM		RN55C499DF
R 16	0075589	RESISTOR 56 OHM 1W 10% COMP	01121	RCR32G560KS
R 17	0083876	RESISTOR 499 OHM RN55C 1% MTL FLM		RN55C499DF
R 18	0079125	RESISTOR 402 OHM RN55C 1% MTL FLM		RN55C402DF
R 19	0171527	RESISTOR 5.11 OHM 1/4W 1% MTL FLM		CMF-55C
R 20	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 21	0083856	RESISTOR 110 OHM RN55C 1% MTL FLM		RN55C1100F
R 22	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 23	0083891	RESISTOR 1.50K OHM RN55C 1% MTL FLM		RN55C1501F
R 24	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 25	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 26	0171527	RESISTOR 5.11 OHM 1/4W 1% MTL FLM		CMF-55C
R 27	0079125	RESISTOR 402 OHM RN55C 1% MTL FLM		RN55C402DF
R 28	0083876	RESISTOR 499 OHM RN55C 1% MTL FLM		RN55C4990F
R 29	0075589	RESISTOR 56 OHM 1W 10% COMP	01121	RCR32G560KS
R 30	0083876	RESISTOR 499 OHM RN55C 1% MTL FLM		RN55C499DF
R 31	0079125	RESISTOR 402 OHM RN55C 1% MTL FLM		RN55C402DF
R 32	0083856	RESISTOR 110 OHM RN55C 1% MTL FLM		RN55C1100F
R 33	0171527	RESISTOR 5.11 OHM 1/4W 1% MTL FLM		CMF-55C
R 34	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 35	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 36	0083891	RESISTOR 1.50K OHM RN55C 1% MTL FLM		RN55C1501F
R 37	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 38	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 39	0171527	RESISTOR 5.11 OHM 1/4W 1% MTL FLM		CMF-55C
R 40	0079125	RESISTOR 402 OHM RN55C 1% MTL FLM		RN55C402DF
R 41	0083876	RESISTOR 499 OHM RN55C 1% MTL FLM		RN55C4990F
R 42	0075589	RESISTOR 56 OHM 1W 10% COMP	01121	RCR32G560KS
R 43	0083876	RESISTOR 499 OHM RN55C 1% MTL FLM		RN55C499DF
R 44	0079125	RESISTOR 402 OHM RN55C 1% MTL FLM		RN55C402DF
R 45	0083856	RESISTOR 110 OHM RN55C 1% MTL FLM		RN55C1100F
R 46	0171527	RESISTOR 5.11 OHM 1/4W 1% MTL FLM		CMF-55C
R 47	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 48	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 49	0083891	RESISTOR 1.50K OHM RN55C 1% MTL FLM		RN55C1501F
R 50	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 51	0083850	RESISTOR 53.6 OHM RN55C 1% MTL FLM		RN55C53R6F
R 52	0171527	RESISTOR 5.11 OHM 1/4W 1% MTL FLM		CMF-55C
R 53	0079122	RESISTOR 200 OHM RN55C 1% MTL FLM		RN55C200DF
R 54	0083867	RESISTOR 249 OHM RN55C 1% MTL FLM		RN55C249DF
R 55	0172042	RESISTOR 75 OHM 1W 5% COMP		RCR32G750JS
R 56	0083867	RESISTOR 249 OHM RN55C 1% MTL FLM		RN55C2490F
R 57	0079120	RESISTOR 200 OHM RN55C 1% MTL FLM		RN55C200DF
R 58		NOT ASSIGNED		
R 59	0083829	RESISTOR 17.8 OHM RN55D 1% MTL FLM		RN55D17R8F
R 60	0083089	RESISTOR 75.0 OHM RN55C 1% MTL FLM		RN55C75R0F
R 61	0083841	RESISTOR 31.6 OHM RN55D 1% MTL FLM		RN55D31R6F

TRANSMITTER OUTPUT AMPLIFIER PCB ASSEMBLY - 252713

REF DESIG PREFIX: 4653A-A1

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 62	0083094	RESISTOR 174 OHM RN55C 1% MTL FLM		RN55C1740F
R 63	0083829	RESISTOR 17.8 OHM RN55D 1% MTL FLM		RN55D17R8F
R 64	0083089	RESISTOR 75.0 OHM RN55C 1% MTL FLM		RN55C75R0F
R 65	0083089	RESISTOR 75.0 OHM RN55C 1% MTL FLM		RN55C75R0F
R 66	0083841	RESISTOR 31.6 OHM RN55D 1% MTL FLM		RN55D31R6F
R 67	0083871	RESISTOR 316 OHM RN55C 1% MTL FLM		RN55C3160F
R 68	0083094	RESISTOR 174 OHM RN55C 1% MTL FLM		RN55C1740F
R 69	0083086	RESISTOR 56.2 OHM RN55C 1% MTL FLM		RN55C56R2F
R 70	0083095	RESISTOR 226 OHM RN55C 1% MTL FLM		RN55C2260F
R 71	0083095	RESISTOR 226 OHM RN55C 1% MTL FLM		RN55C2260F
R 72	0071879	RESISTOR 82 OHM 1/4W 10% COMP	01121	RCR07G820KS
R 73	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 74	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 75	0083855	RESISTOR 105 OHM RN55C 1% MTL FLM		RN55C1C50F
R 76	0080380	RESISTOR 2.74K OHM RN55C 1% MTL FLM		RN55C2741F
R 77	0083856	RESISTOR 110 OHM RN55C 1% MTL FLM		RN55C1100F
R 78	0083856	RESISTOR 110 OHM RN55C 1% MTL FLM		RN55C1100F
R 79	0080380	RESISTOR 2.74K OHM RN55C 1% MTL FLM		RN55C2741F
R 80	0071938	RESISTOR 680 OHM 1/4W 10% COMP	01121	RCR07G681KS
R 81		NOT ASSIGNED		
R 82	0083871	RESISTOR 316 OHM RN55C 1% MTL FLM		RN55C3160F
R 83	0083089	RESISTOR 75.0 OHM RN55C 1% MTL FLM		RN55C75R0F
R 84		NOT ASSIGNED		
R 85	0087835	POT 200 OHM 1/2W CER 3/8 SQ VERT ADJ 25T		3299W-1-201
R 86	0083866	RESISTOR 237 OHM RN55C 1% MTL FLM		RN55C2370F
R 87	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
T 1	0170318	XFMR MATCHING .01-100 MHZ 50 IN 250 OUT		TMC2.5-6T
T 2	0170318	XFMR MATCHING .01-100 MHZ 50 IN 250 OUT		TMC2.5-6T
T 3	0170318	XFMR MATCHING .01-100 MHZ 50 IN 250 OUT		TMC2.5-6T
T 4	0170318	XFMR MATCHING .01-100 MHZ 50 IN 250 OUT		TMC2.5-6T
T 5	0170318	XFMR MATCHING .01-100 MHZ 50 IN 250 OUT		TMC2.5-6T
T 6	0170319	XFMR 1:1:1 PRI L 500 UH PRI/SEC C 32 PF		5762
U 1	0081658	IC TTL BUFFER HEX OPEN-COL	01295	SN7407N
U 2	0081658	IC TTL BUFFER HEX OPEN-COL	01295	SN7407N
U 3	0081658	IC TTL BUFFER HEX OPEN-COL	01295	SN7407N

TRANSMITTER DATA GENERATOR PCB ASSEMBLY - 304131

REF DESIG PREFIX: 4653A-A2

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 2	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 3	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 4	0083649	CAPACITR 7-25 PF MIN CER DISC PC MT	72982	538-011-B-7-25
C 5	0083649	CAPACITR 7-25 PF MIN CER DISC PC MT	72982	538-011-B-7-25
C 6	0083649	CAPACITR 7-25 PF MIN CER DISC PC MT	72982	538-011-B-7-25
C 7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 8	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 9	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 10	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 11	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 12	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 13	0070671	CAPACITR 100 MF 25V	80183	500D107G025DD7
C 14	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 15	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 16	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 17	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 18	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 19	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 20	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 21	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 22	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
J 1	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC		87220-3
J 2	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC		87220-3
J 3	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC		87220-3
J 4	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC		87220-3
L 1	0081718	CORE BEAD FERRITE 70 .138X.037X.150L GRN	78488	57-1413
L 2	0081718	CORE BEAD FERRITE 70 .138X.037X.150L GRN	78488	57-1413
P 2	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
P 3	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
P 4	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
P 5	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
Q 1	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 2	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
R 1	0071879	RESISTOR 82 OHM 1/4W 10% COMP	01121	RCR07G820KS
R 2	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 3	0071926	RESISTOR 470 OHM 1/4W 10% COMP	01121	RCR07G471KS
R 4	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 5	0077524	RESISTOR 75 OHM 1/4W 5% COMP	01121	RCR07G750JS
R 6	0076274	RESISTOR 18 OHM 1/4W 10% COMP	01121	RCR07G180KS
R 7	0076274	RESISTOR 18 OHM 1/4W 10% COMP	01121	RCR07G180KS
R 8	0076274	RESISTOR 18 OHM 1/4W 10% COMP	01121	RCR07G180KS
R 9	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 10	0071966	RESISTOR 1.5K OHM 1/4W 10% COMP	01121	RCR07G152KS
R 11	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 12	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 13	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
TP 1		NOT ASSIGNED		
TP 2		NOT ASSIGNED		
TP 3	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TP 4	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TP 5	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
U 1	0252731	OSCILLATOR,CLOCK 6.176MHZ MDL 4653		
U 2	0256265	OSCILLATOR CLOCK 6.304 MHZ MDL 4653		
U 3	0256266	OSCILLATOR CLOCK 6.312 MHZ MDL 4653		
U 4	0087804	IC TTL COUNTER BIN 35-MHZ DUAL		SN74LS393J
U 5	0084283	IC TTL FLIP-FLOP TYPE-D DUAL	01295	SN74LS74AN
U 6	0084281	IC TTL GATE INVERTER HEX	01295	SN74LS04N

TRANSMITTER DATA GENERATOR PCB ASSEMBLY - 304131

REF DESIG PREFIX: 4653A-A2

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
U 7	0170306	IC TTL MULTIPLEXER 4-BIT/1-CHNL TO 1DUAL		SN74LS153N
U 8	0087689	IC TTL REGISTER SHIFT 8-BIT S-IN P-OUT		LS164J
U 9	0087689	IC TTL REGISTER SHIFT 8-BIT S-IN P-OUT		LS164J
U 10	0087689	IC TTL REGISTER SHIFT 8-BIT S-IN P-OUT		LS164J
U 11	0084277	IC TTL GATE EX-OR 2-IN QUAD	01295	SN74LS86N
U 12	0084284	IC TTL GATE NOR 3-IN TRIPLE	01295	SN74LS27N
U 13	0084284	IC TTL GATE NOR 3-IN TRIPLE	01295	SN74LS27N
U 14	0084284	IC TTL GATE NOR 3-IN TRIPLE	01295	SN74LS27N
U 15	0087488	IC TTL GATE AND 3-IN TRIPLE		SN74LS11N
U 16	0084283	IC TTL FLIP-FLOP TYPE-D DUAL	01295	SN74LS74AN
U 17	0085942	IC TTL COUNTER DECADE 25-MHZ U/D		SN74LS193N
U 18	0087686	IC TTL MULTIPLEXER 8-BIT/1-CHNL TO 1		SN74LS151J
U 19	0084516	RESISTOR NETWORK 15 22K OHM 2% 16 DIP	80294	4116R-002-223
U 20	0083296	SWITCH SPST 8 PCS PC MT DIP	00779	435166-5
U 21	0087686	IC TTL MULTIPLEXER 8-BIT/1-CHNL TO 1		SN74LS151J
U 22	0087694	IC TTL BUFFER NAND 4-IN DUAL		SN74S140J
U 23	0089528	IC TTL FLIP-FLOP TYPE-JK* DUAL		SN74LS109AN
U 24	0087694	IC TTL BUFFER NAND 4-IN DUAL		SN74S140J
U 25	0170306	IC TTL MULTIPLEXER 4-BIT/1-CHNL TO 1DUAL		SN74LS153N
U 26	0171591	IC TTL MULTIPLEXER 8-BIT/1-CHNL TO 1		74F151PC
U 27	0171591	IC TTL MULTIPLEXER 8-BIT/1-CHNL TO 1		74F151PC
U 28	0087488	IC TTL GATE AND 3-IN TRIPLE		SN74LS11N
XU 1	0086648	SOCKET 14 PIN DIP PC MT		ICT-142-S-T
XU 2	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
XU 3	0086648	SOCKET 14 PIN DIP PC MT		ICT-143-S-T
XU 20	0086649	SOCKET 16 PIN DIP PC MT		ICT-163-S-T

TRANSMITTER MULTIPLEXER PCB ASSEMBLY - 304174

REF DESIG PREFIX: 4653A-A3

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 2	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 3		NOT ASSIGNED		
C 4	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 5	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 6	0078600	NOT ASSIGNED		
C 7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 8	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 9	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 10	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 11		NOT ASSIGNED		
C 12	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 13	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 14	0070544	CAPACITR .001 MF 1KV CER DISC Z5F 10%	71590	DD102
C 15	0070671	CAPACITR 100 MF 25V	80183	5CCD107G025CD7
C 16	0077593	CAPACITR 390 PF 1KV CER DISC Z5F 10%	71590	DD391
J 1	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC		87220-2
J 2	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC		87220-2
J 3	0087229	CONN HEADER SGL ROW STRAIGHT 2-PIN PC		87220-2
P 2	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
P 3	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
P 4	0086884	JUMPER FEMALE INSULATED .10 SPACING		65474-004
R 1	0072054	RESISTOR 22K OHM 1/4W 10% COMP	01121	RCR07G223KS
R 2	0072054	RESISTOR 22K OHM 1/4W 10% COMP	01121	RCR07G223KS
R 3	0076274	RESISTOR 18 OHM 1/4W 10% COMP	01121	RCR07G180KS
R 4	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 5	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 6	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 7	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 8	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
TP 1		NOT ASSIGNED		
TP 2		NOT ASSIGNED		
TP 3	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
U 1	0084960	IC TTL COUNTER BIN 35-MHZ	01295	SN74LS161AN
U 2	0084960	IC TTL COUNTER BIN 35-MHZ	01295	SN74LS161AN
U 3	0086646	IC TTL DECODER 2-BIT TO 1 OF 4 DUAL		SN74LS139N
U 4	0084878	IC TTL COUNTER BIN 18-MHZ DIVIDE 2X6	01295	SN74LS92N
U 5	0084283	IC TTL FLIP-FLOP TYPE-D DUAL	01295	SN74LS74AN
U 6		NOT ASSIGNED		
U 7		NOT ASSIGNED		
U 8	0084829	IC TTL MULTIPLEXER 4-BIT/2-CHNL TO 1		
U 9	0084279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS157N
U 10	0170306	IC TTL MULTIPLEXER 4-BIT/1-CHNL TO 1DUAL	01295	SN74LS00N
U 11	0087804	IC TTL COUNTER BIN 35-MHZ DUAL		SN74LS153N
U 12	0084283	IC TTL FLIP-FLOP TYPE-D DUAL		SN74LS393J
U 13	0084283	IC TTL FLIP-FLOP TYPE-D DUAL	01295	SN74LS74AN
U 14	0170306	IC TTL MULTIPLEXER 4-BIT/1-CHNL TO 1DUAL	01295	SN74LS74AN
U 15	0087691	IC TTL ADDER 4-BIT FULL		SN74LS153N
U 16	0170308	IC TTL LATCH 8-BIT ADDRESSABLE		SN74LS283J
U 17	0087686	IC TTL MULTIPLEXER 8-BIT/1-CHNL TO 1		SN74LS259N
U 18	0170305	IC TTL COMPARATOR MAGNITUDE 4-BIT		SN74LS151J
U 19		NOT ASSIGNED		SN74LS85N
U 20	0084279	IC TTL GATE NAND 2-IN QUAD		
U 21	0084284	IC TTL GATE NOR 3-IN TRIPLE	01295	SN74LS00N
U 22	0084281	IC TTL GATE INVERTER HEX	01295	SN74LS27N
U 23	0084279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS04N
U 24	0084277	IC TTL GATE EX-OR 2-IN QUAD	01295	SN74LS00N
U 25		NOT ASSIGNED	01295	SN74LS86N
U 26	0087686	IC TTL MULTIPLEXER 8-BIT/1-CHNL TO 1		
U 27	0087694	IC TTL BUFFER NAND 4-IN DUAL		SN74LS151J
U 28	0084960	IC TTL COUNTER BIN 35-MHZ		SN74S140J
			01295	SN74LS161AN

TRANSMITTER DS1 FRAMING PCB ASSEMBLY - 304128

REF DESIG PREFIX: 4653A-A4

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0070671	CAPACITR 100 MF 25V	80183	500D107G025DD7
C 2	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 3	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 4	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 5	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 6	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 7	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 8	0081826	CAPACITR 110 PF 100V SILVER MICA 2%	53021	D151C111G03
J 1	0087366	CONN HEADER SGL ROW STRAIGHT 3-PIN PC		87220-3
R 1	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 2	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 3	0071985	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 4	0076274	RESISTOR 18 OHM 1/4W 10% COMP	01121	RCR07G180KS
U 1	0173650	IC XMTR PARALLEL IN TO SERIAL TI OUT		R8050
U 2	0087689	IC TTL REGISTER SHIFT 8-BIT S-IN P-OUT		LS164J
U 3	0084281	IC TTL GATE INVERTER HEX	01295	SN74LS04N
U 4	0084280	IC TTL GATE NOR 2-IN QUAD	01295	SN74LS02N
U 5	0170306	IC TTL MULTIPLEXER 4-BIT/1-CHNL TO 1DUAL		SN74LS153N
U 6	0087686	IC TTL MULTIPLEXER 8-BIT/1-CHNL TO 1		SN74LS151J
U 7	0084283	IC TTL FLIP-FLOP TYPE-D DUAL	C1295	SN74LS74AN
U 8	0087488	IC TTL GATE AND 3-IN TRIPLE		SN74LS11N
U 9	0085948	IC TTL FLIP-FLOP TYPE-D OCTAL		SN74LS377N
U 10	0087694	IC TTL BUFFER NAND 4-IN DUAL		SN74S140J
XU 1	0086652	SOCKET 28 PIN DIP PC MT		ICT-286-S-TG30

TRANSMITTER ERROR COUNT/INSERT PCB ASSEMBLY - 304177

REF DESIG PREFIX: 4653A-A5

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0070518	CAPACITR 100 PF 1KV CER DISC S3N 10%	71590	DD-1C1
C 2	0070518	CAPACITR 100 PF 1KV CER DISC S3N 10%	71590	DD-101
C 3	0070528	CAPACITR 200 PF 1KV CER DISC S3N 10%	71590	DD-201
C 4	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 5	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 6	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 7	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 8	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 9	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 10	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 11	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 12	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 13	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 14	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 15	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 16	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 17	0070671	CAPACITR 100 MF 25V	80183	500D107G025DD7
R 1	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 2	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 3	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 4	0076274	RESISTOR 18 OHM 1/4W 10% COMP	01121	RCR07G180KS
R 5	0071931	RESISTOR 560 OHM 1/4W 10% COMP	01121	RCR07G561KS
R 6	0072054	RESISTOR 22K OHM 1/4W 10% COMP	01121	RCR07G223KS
TP 1		NOT ASSIGNED		
TP 2		NOT ASSIGNED		
U 1	0087456	IC TTL MULTIPLIER RATE DECADE		SN74167N
U 2	0089527	IC TTL COUNTER DECADE 35-MHZ 2X5 DUAL		SN74LS390N
U 3	0089527	IC TTL COUNTER DECADE 35-MHZ 2X5 DUAL		SN74LS390N
U 4	0089527	IC TTL COUNTER DECADE 35-MHZ 2X5 DUAL		SN74LS390N
U 5	0089527	IC TTL COUNTER DECADE 35-MHZ 2X5 DUAL		SN74LS390N
U 6	0087686	IC TTL MULTIPLEXER 8-BIT/1-CHNL TC 1		SN74LS151J
U 7	0089528	IC TTL FLIP-FLOP TYPE-JK* DUAL		SN74LS109AN
U 8	0084829	IC TTL MULTIPLEXER 4-BIT/2-CHNL TC 1	01295	SN74LS157N
U 9	0171596	IC TTL FLIP-FLOP TYPE-JK DUAL		74F109PC
U 10	0084283	IC TTL FLIP-FLOP TYPE-D DUAL	01295	SN74LS74AN
U 11	0084279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U 12	0087689	IC TTL REGISTER SHIFT 8-BIT S-IN P-OUT		LS164J
U 13	0089528	IC TTL FLIP-FLOP TYPE-JK* DUAL		SN74LS109AN
U 14	0170307	IC TTL REGISTER SHIFT 4-BIT BIDIRECTNAL		SN74LS194N
U 15	0170307	IC TTL REGISTER SHIFT 4-BIT BIDIRECTNAL		SN74LS194N
U 16	0087686	IC TTL MULTIPLEXER 8-BIT/1-CHNL TC 1		SN74LS151J
U 17	0085946	IC TTL GATE NAND 3-IN TRIPLE		SN74LS10N
U 18	0084278	IC TTL GATE NAND 4-IN DUAL		SN74LS20N
U 19	0084282	IC TTL GATE AND 2-IN QUAD		SN74LS08N
U 20	0084277	IC TTL GATE EX-OR 2-IN QUAD		SN74LS86N
U 21	0084282	IC TTL GATE AND 2-IN QUAD		SN74LS08N
U 22	0085946	IC TTL GATE NAND 3-IN TRIPLE		SN74LS10N
U 23	0084284	IC TTL GATE NOR 3-IN TRIPLE		SN74LS27N
U 24	0084281	IC TTL GATE INVERTER HEX		SN74LS04N
U 25	0084960	IC TTL COUNTER BIN 35-MHZ		SN74LS161AN
U 26	0088107	RESISTOR NETWORK 13 2.2K OHM 2% 14 DIP		
U 27	0087694	IC TTL BUFFER NAND 4-IN DUAL		SN74S140J
U 28	0084285	IC TTL GATE OR 2-IN QUAD		SN74LS32N

TRANSMITTER FRONT PANEL INTERFACE PCB ASSEMBLY - 304134

REF DESIG PREFIX: 4653A-A6

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
C 1	0086258	CAPACITR .0047 MF 100V SILVER MICA 1%		D191F472F03
C 2	0081101	CAPACITR 1 MF 50V CER MCNC 20%	72982	8131-050-651-105M
C 3	0081101	CAPACITR 1 MF 50V CER MCNC 20%	72982	8131-050-651-105M
C 4	0070671	CAPACITR 100 MF 25V	80183	50CD107GC25DD7
C 5	0070671	CAPACITR 100 MF 25V	80183	50CD107GC25DD7
J 1	0171549	CONN HEADER DBL RCW RT ANGLE 50-PIN LTCH		3433-1202
R 1	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	C1121	RCR07G102KS
U 1	0087093	RESISTOR NETWORK 7 22K OHM 2% 8 SIP		4308R-101-223
U 2	0087488	IC TTL GATE AND 3-IN TRIPLE		SN74LS11N
U 3	0088501	IC CMOS CONTACT BOUNCE ELIM HEX 16L -DIP		MC14490FL
U 4	0084277	IC TTL GATE EX-OR 2-IN QUAD	01295	SN74LS86N
U 5	0084829	IC TTL MULTIPLEXER 4-BIT/2-CHNL TC 1	01295	SN74LS157N
U 6	0084279	IC TTL GATE NAND 2-IN QUAD	01295	SN74LS00N
U 7	0084282	IC TTL GATE AND 2-IN QUAD	01295	SN74LS08N

TRANSMITTER MOTHERBOARD PCB ASSEMBLY - 304137

REF DESIG PREFIX: 4653A-A9

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
J 1	0089673	CONN HEADER SGL ROW STRAIGHT 12-PIN PC		1-85830-2
J 2	0170200	CONN HEADER SGL ROW STRAIGHT 12-PIN PC		1-87220-2
J 3	0088345	CONN HEADER DBL ROW STRAIGHT 14-PIN PC		87515-3
XA 1	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 2	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 3	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 4	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 5	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3
XA 6	0087039	CONN 43 PIN EDGE TYPE LOW PROFILE		1-530655-3

TRANSMITTER POWER SUPPLY PCB ASSEMBLY - 252725
(AC VERSION ONLY)

REF DESIG PREFIX: 4653A-A10

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
2	0081453	FUS HLDR CLIP FOR 3AG OR 3AB PC MT 2 PIN	75963	798
C 1	0171532	CAPACITR 15000 MF 16V		159ITAC16APX
C 2	0077014	CAPACITR 4.7 MF 35V SOLID TANT POL 10%	05397	T330C475K035AS
C 3	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 4	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 5	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 6	0171531	CAPACITR 4700 MF 35V		478ITA035APX
C 7	0077014	CAPACITR 4.7 MF 35V SOLID TANT POL 10%	05397	T330C475K035AS
C 8	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 9	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 10	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 11	0171531	CAPACITR 4700 MF 35V		478ITA035APX
C 12	0077014	CAPACITR 4.7 MF 35V SOLID TANT POL 10%	05397	T330C475K035AS
C 13	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 14	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 15	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 16	0070651	CAPACITR 25 MF 25V	80183	500D256G025CB7
C 17	0078600	NOT ASSIGNED		
C 18	0080149	CAPACITR 4.7 MF 20V SOLID TANT POL 20%	80183	196D475X0020JE3
CR 1		NOT ASSIGNED		
CR 2	0089538	DIODE 1N6267A ZEN TRAN SUPPRESSOR 6.8 V		1N6267A
CR 3	0082901	LAMP LED GRN .190 DIA .180 LNG 2.3V 20MA	31718	FLV340
CR 4	0085492	RECTIFIER ASSY 200V 6A	83003	VF24E
CR 5	0082901	LAMP LED GRN .190 DIA .180 LNG 2.3V 20MA	31718	FLV340
CR 6	0082901	LAMP LED GRN .190 DIA .180 LNG 2.3V 20MA	31718	FLV340
CR 7	0089538	DIODE 1N6267A ZEN TRAN SUPPRESSOR 6.8 V		1N6267A
CR 8	0082901	LAMP LED GRN .190 DIA .180 LNG 2.3V 20MA	31718	FLV340
CR 9	0079488	DIODE 1N5302 CURRENT REGULATOR 1.5MA	04713	1N5302
CR 10	0071122	DIODE 1N914 SIL 75V 75MA	80386	1N914
CR 11	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 12	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 13	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 14	0089539	DIODE 1N6275A ZEN TRAN SUPPRESSOR 15 V		1N6275A
CR 15	0089539	DIODE 1N6275A ZEN TRAN SUPPRESSOR 15 V		1N6275A
CR 16	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 17	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
F 1	0071229	FUSE 4 AMP	75915	3AG 312004.
F 2	0071223	FUSE 2 AMP	75915	3AG 312002.
F 3	0071223	FUSE 2 AMP	75915	3AG 312002.
J 1	0087353	CONN RECT PIN HEADER PC BD 16 CIRCUIT		350214-1
J 2	0087042	CONN RECT PIN HEADER PC BD 10 CIRCUIT		1-380991-0
Q 1	0088412	THYRISTOR SCR 50PRV 25A RMS		2N6504
Q 2	0088412	THYRISTOR SCR 50PRV 25A RMS		2N6504
Q 3	0088412	THYRISTOR SCR 50PRV 25A RMS		2N6504
Q 4	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 5	0078215	TRANSSTR 2N5089 NPN SIL	04713	2N5089
R 1		NOT ASSIGNED		
R 2		NOT ASSIGNED		
R 3	0079743	RESISTOR 750 OHM RN55C 1% MTL FLM		RN55C7500F
R 4	0083903	RESISTOR 3.32K OHM RN55C 1% MTL FLM		RN55C3321F
R 5	0083901	RESISTOR 2.61K OHM RN55C 1% MTL FLM		RN55C2611F
R 6	0076275	RESISTOR 22 OHM 1/4W 10% COMP	C1121	RCR07G220KS
R 7	0071907	RESISTOR 220 OHM 1/4W 10% COMP	C1121	RCR07G221KS
R 8	0071913	RESISTOR 270 OHM 1/4W 10% COMP	C1121	RCR07G271KS
R 9	0171526	RESISTOR .3 OHM 5W 5% WW		RS-5
R 10	0171526	RESISTOR .3 OHM 5W 5% WW		RS-5
R 11		NOT ASSIGNED		
R 12	0087837	POT 1K OHM 1/2W CER 3/8 SQ VERT ADJ 25T		3299W-1-102

TRANSMITTER POWER SUPPLY PCB ASSEMBLY - 252725
(AC VERSION ONLY)

REF DESIG PREFIX: 4653A-A10

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 13	0083917	RESISTOR 11.5K OHM RN55C 1% MTL FLM		RN55C1152F
R 14	0C839C1	RESISTOR 2.61K OHM RN55C 1% MTL FLM		RN55C2611F
R 15	0C71862	RESISTOR 47 OHM 1/4W 10% COMP	C1121	RCR07G47CKS
R 16	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 17	0C71941	RESISTOR 820 OHM 1/4W 10% COMP	C1121	RCR07GE21KS
R 18	0C87837	POT 1K OHM 1/2W CER 3/8 SQ VERT ADJ 25T		3299W-1-102
R 19		NOT ASSIGNED		
R 20	0083917	RESISTOR 11.5K OHM RN55C 1% MTL FLM		RN55C1152F
R 21	0C839C1	RESISTOR 2.61K OHM RN55C 1% MTL FLM		RN55C2611F
R 22	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 23	0071941	RESISTOR 820 OHM 1/4W 10% COMP	C1121	RCR07GE21KS
R 24	0C86963	RESISTOR 10 OHM 3W WW 5%		WAL3
R 25	0083867	RESISTOR 249 OHM RN55C 1% MTL FLM		RN55C2490F
R 26	0079743	RESISTOR 750 OHM RN55C 1% MTL FLM		RN55C75C0F
R 27	0C71913	RESISTOR 270 OHM 1/4W 10% COMP	C1121	RCR07G271KS
R 28	0C84059	RESISTOR 6.98K OHM RN55C 1% MTL FLM		RN55C6981F
R 29	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 30	0C71926	RESISTOR 470 OHM 1/4W 10% COMP	C1121	RCR07G471KS
R 31	0C71977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
R 32	0083891	RESISTOR 1.50K OHM RN55C 1% MTL FLM		RN55C1501F
R 33	0C83851	RESISTOR 1.50K OHM RN55C 1% MTL FLM		RN55C1501F
TP 1	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TP 2	0C829C9	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TP 3	0C82909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TP 4	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TP 5	0C829C9	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TP 6	0C82909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
U 1	0086C86	IC OVERVOLTAGE CROWBAR SENSING CIRCUIT		MC3423L
U 2	0C860E6	IC OVERVOLTAGE CROWBAR SENSING CIRCUIT		MC3423L
U 3	0086086	IC OVERVOLTAGE CROWBAR SENSING CIRCUIT		MC3423L
U 4	0C88334	IC VLTG RGLTR -1.2 TO -37V .8A TYP TO22C		LM337T

TRANSMITTER -5.2V/-12V POWER SUPPLY PCB ASSEMBLY - 220905
(AC/DC VERSION ONLY)

REF DESIG PREFIX: 4653A-A10

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
002	0079335	PAD TRANSSTR TO5 & TO18 TO TO5	13103	7717-44-CAF
003	0077828	INSULATR THERMA-FILM FOR TO-3 TRANSISTOR	13103	43-03-4
C 001	0081099	CAPACITR .0047 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-472K
C 002	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 003	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 004	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 005	0086013	CAPACITR 22 MF 25V SOLID TANT POL 10%	80183	T362C226K025AS
C 006	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 007	0084225	CAPACITR .22 MF 100V CER MONO 20%	72982	8131-100-651-224M
C 008	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 009	0081210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 010	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D151CXXXJ03 5980 PF
C 011	0070518	CAPACITR 100 PF 1KV CER DISC S3N 10%	71590	DD-101
C 012	0089645	CAPACITR 220 MF 6CV		673D227H006JE5C
C 013	0170264	CAPACITR 1 MF 100V CER MONO 651 20%		8141-100-651-105M
C 014	0170264	CAPACITR 1 MF 100V CER MONO 651 20%		8141-100-651-105M
C 015	0089643	CAPACITR 1000 MF 15V		672D108H015E15C
C 016	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 017	0089644	CAPACITR 1000 MF 20V		673D108H020JE5C
C 018	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 019	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 020	0170263	CAPACITR 100 MF 20V		672D107H020CE5C
C 021	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 022	0081099	CAPACITR .0047 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-472K
C 023	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 024	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D151CXXXJ03 5980 PF
C 025	0070518	CAPACITR 100 PF 1KV CER DISC S3N 10%	71590	DD-101
C 026	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 027	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 028	0170263	CAPACITR 100 MF 20V		672D107H020CE5C
C 029	0080145	CAPACITR 4.7 MF 20V SOLID TANT POL 20%	80183	196D475X0020JE3
C 030	0080149	CAPACITR 4.7 MF 20V SOLID TANT POL 20%	80183	196D475X002CJE3
C 031	0089643	CAPACITR 1000 MF 15V		672D108H015E15C
C 032	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 033	0080139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 034	0080148	CAPACITR 10 MF 20V SOLID TANT POL 20%	80183	T362B106M020AS
C 035	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
CR001	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR002	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR003	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR004	0071121	DIODE 1N821 TC REF 6.2V .01% .4W	04713	1N821
CR005	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR006	0083986	DIODE 1N4746A SI ZEN 18V 5% 1W	04713	1N4746A
CR007	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR008	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR009	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR010	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR011	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR012	0089684	DIODE MR821 SIL 100V 5A FAST REC		MR821
CR013	0171572	THYRISTOR SCR 200PRV 25A RMS		C12985
CR014	0071121	DIODE 1N821 TC REF 6.2V .01% .4W	04713	1N821
CR015	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR016	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR017	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR018	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR019	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR020	0089679	DIODE 80SQC3C SIL 30V 8A SCHOTTKY		80SQC3C
CR021	0082901	LAMP LED GRN .150 DIA .180 LNG 2.3V 20MA	31718	FLV340
CR022	0082901	LAMP LED GRN .150 DIA .180 LNG 2.3V 20MA	31718	FLV340
CR023	0078714	DIODE 1N4744A SI ZEN 15V 5% 1W	04713	1N4744A
CR024	0071143	DIODE 1N4735A SI ZEN 6.2V 5% 1W	04713	1N4735A
CR025	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR026	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
J 001	0087042	CONN RECT PIN HEADER PC BD 10 CIRCUIT		1-380991-0
J 002	0087357	CONN RECT PIN HEADER PC BD 2 CKT BLUE		6-350539-2

TRANSMITTER -5.2V/-12V POWER SUPPLY PCB ASSEMBLY - 220905
(AC/DC VERSION ONLY)

REF DESIG PREFIX: 4653A-A10

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
L 001	0078841	INDUCTOR 4.7 MH MIN SHLD ENCAP 10%	72259	WEE-47CC
L 002	CC89688	INDUCTOR 1.5 UH FERRITE 16.2 A PC MT		3443-04
L 003	0220937	COIL ASSY 65C UHY SER 4650		
L 004	0089683	INDUCTOR 50 UH UNSHLD 10%		6310-6
L 005	0089688	INDUCTOR 1.5 UH FERRITE 16.2 A PC MT		3443-04
L 006	0078841	INDUCTOR 4.7 MH MIN SHLD ENCAP 10%	72259	WEE-4700
L 007	0220936	COIL ASSY 420 UHY SER 4650		
Q 001	0076316	TRANSSTR 2N4036 PNP SIL	79089	2N4036S
Q 002	0084113	TRANSSTR TIP 111 NPN SIL DARLINGTON PAIR	01295	TIP 111
Q 003	0077147	TRANSSTR 2N3947 NPN SIL	04713	2N3947
Q 004	0080007	TRANSSTR 2N2102 NPN SIL	79089	2N2102
Q 005	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 006	0089669	TRANSSTR IRF132 FET N-CHNL MOS POWER		IRF132
Q 007	0081633	TRANSTR MPS-L51 PNP SIL	04713	MPS-L51
Q 008	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 009	0089669	TRANSSTR IRF132 FET N-CHNL MOS POWER		IRF132
Q 010	0080824	TRANSSTR 2N5415 PNP SIL	04713	2N5415
Q 011	0080824	TRANSSTR 2N5415 PNP SIL	04713	2N5415
Q 012	0078214	TRANSSTR 2N5087 PNP SIL	04713	2N5087
R 001	0072040	RESISTOR 15K OHM 1/2W 10% COMP	01121	RCR20G153KS
R 002	0071879	RESISTOR 82 OHM 1/4W 10% COMP	01121	RCR07G820KS
R 003	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 004	0071833	RESISTOR 6.8 OHM 1/2W 10% COMP	01121	RCR20G6R8KS
R 005	0078929	RESISTOR 1.00K OHM RN55C 1% MTL FLM		RN55C1001F
R 006	0083885	RESISTOR 1.40K OHM RN55C 1% MTL FLM		RN55C1401F
R 007	0085551	POT 5K OHM 1/2W CER 3/8 SQ HOR ADJ 20T	73138	66XR5K
R 008	0072068	RESISTOR 39K OHM 1/4W 10% COMP	01121	RCR07G393KS
R 009	0071982	RESISTOR 2.7K OHM 1/4W 10% COMP	01121	RCR07G272KS
R 010	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 011	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 012	0071941	RESISTOR 820 OHM 1/4W 10% COMP	01121	RCR07G821KS
R 013	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 014	0083907	RESISTOR 4.22K OHM RN55C 1% MTL FLM		RN55C4221F
R 015	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 016	0074714	RESISTOR 3.3K OHM 1/4W 5% COMP	01121	RCR07G332JS
R 017	0074675	RESISTOR 100 OHM 1/4W 5% COMP	01121	RCR07G101JS
R 018	0087584	RESISTOR .10 OHM 3W 1%		RS-2C .1C OHM 1%
R 019	0076356	RESISTOR 1.0 OHM 1/2W 10% COMP	01121	RCR20G1R0KS
R 020	0071827	RESISTOR 4.7 OHM 1W 10% COMP	01121	RCR32G4R7KS
R 021	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 022	0078931	RESISTOR 4.99K OHM RN55C 1% MTL FLM		RN55C4991F
R 023	0088389	POT 2K OHM 1/2W CER 3/8 SQ HOR ADJ 25T		3299X-1-202
R 024	0076981	RESISTOR 5.90K OHM RN55C 1% MTL FLM		RN55C59C1F
R 025	0079085	RESISTOR 10C OHM 3W WW 5%	24681	VAL-3
R 026	0079128	RESISTOR 768 OHM RN55C 1% MTL FLM		RN55C7680F
R 027	0071873	RESISTOR 56 OHM 1/4W 10% COMP	01121	RCR07G560KS
R 028	0072035	RESISTOR 15K OHM 1/4W 10% COMP	01121	RCR07G153KS
R 029	0071973	RESISTOR 1.8K OHM 1/4W 10% COMP	01121	RCR07G182KS
R 030	0085551	POT 5K OHM 1/2W CER 3/8 SQ HOR ADJ 20T	73138	66XR5K
R 031	0072068	RESISTOR 39K OHM 1/4W 10% COMP	01121	RCR07G393KS
R 032	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 033	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 034	0071973	RESISTOR 1.8K OHM 1/4W 10% COMP	01121	RCR07G182KS
R 035	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS

TRANSMITTER -5.2V/-12V POWER SUPPLY PCB ASSEMBLY - 220905
(AC/DC VERSION ONLY)

REF DESIG PREFIX: 4653A-A10

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
R 036	0083901	RESISTOR 2.61K OHM RN55C 1% MTL FLM		RN55C2611F
R 037	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 038	0074714	RESISTOR 3.3K OHM 1/4W 5% COMP	01121	RCR07G332JS
R 039	0074675	RESISTOR 100 OHM 1/4W 5% COMP	01121	RCR07G101JS
R 040	0087584	RESISTOR .10 OHM 3W 1%		RS-2C .10 OHM 1%
R 041	0071939	RESISTOR 68C OHM 1/2W 10% COMP	01121	RCR20G681KS
R 042	0071862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R 043	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 044	0071939	RESISTOR 680 OHM 1/2W 10% COMP	01121	RCR20G681KS
R 045	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 046	0076275	RESISTOR 22 OHM 1/4W 10% COMP	01121	RCR07G220KS
R 047	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 048	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G102KS
R 049	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 050	0071867	RESISTOR 50 OHM 3W WW 5%	24681	VAL3
R 051	0083038	RESISTOR 6.81K OHM RN55C 1% MTL FLM		RN55C6811F
R 052	0079104	RESISTOR 5.36K OHM RN55C 1% MTL FLM		RN55C5361F
R 053	0072039	RESISTOR 15K OHM 1/4W 10% COMP	01121	RCR07G153KS
R 054	0071857	RESISTOR 33 OHM 1/4W 10% COMP	01121	RCR07G330KS
R 055	0072019	RESISTOR 8.2K OHM 1/4W 10% COMP	01121	RCR07G822KS
R 056	0071977	RESISTOR 2.2K OHM 1/4W 10% COMP	01121	RCR07G222KS
TPC01	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TPC02	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TPC03	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TPC04	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
TPC05	0082909	TERMINAL PRESS MT DISCONNECT .058 PIN	00779	60599-1
U 001	0085993	IC VLTG RGLTR/PW MOD 70C 16L-DIP		SG3524
U 002	0084890	IC OP AMP 8L-DIP 70C COMP 741C	04713	MC1741CP1
U 003	0085993	IC VLTG RGLTR/PW MOD 70C 16L-DIP		SG3524
U 004	0084890	IC OP AMP 8L-DIP 70C COMP 741C	04713	MC1741CP1

TRANSMITTER +5.2V/+12V POWER SUPPLY PCB ASSEMBLY - 220917
(AC/DC VERSION ONLY)

REF DESIG PREFIX: 4653A-A11

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
3	0077828	INSULATR THERMA-FILM FOR TO-3 TRANSISTOR	13103	43-03-4
11	0C79335	PAD TRANSSTR TO5 & TO18 TO TO5	13103	7717-44-CAP
C 1	0C80148	CAPACITR 10 MF 20V SOLID TANT PCL 20%	80183	T362B106M020AS
C 2	0061058	CAPACITR .47 MF 50V CER MONO 20%	72982	8131-050-651-474M
C 3	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 4	0070552	CAPACITR .002 MF 1KV CER DISC Z5U 20%	71590	CD202
C 5	0081118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 6	0070516	CAPACITR 100 PF 1KV CER DISC S3N 10%	71590	CD-101
C 7	0C89645	CAPACITR 220 MF 6CV		673D227HCXJE5C
C 8	0070552	CAPACITR .002 MF 1KV CER DISC Z5U 20%	71590	CD202
C 9	0080148	CAPACITR 10 MF 20V SOLID TANT PCL 20%	80183	T362E106M020AS
C 10	0073458	CAPACITR 820 PF 500V SILVER MICA 5%	14655	CD19FD821J03
C 11	0C81101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 12	0C81118	CAPACITR .00598 MF 100V SILVER MICA 5%	53021	D191CXXXJ03 5980 PF
C 13	0070518	CAPACITR 100 PF 1KV CER DISC S3N 10%	71590	CD-101
C 14	0082262	CAPACITR .033 MF 50V CER MONO 20%	72982	8121-050-651-333M
C 15	0089643	CAPACITR 1000 MF 15V		672D108M015ET5C
C 16	0080149	CAPACITR 4.7 MF 20V SOLID TANT PCL 20%	80183	196D475X0C2CJE3
C 17	0170264	CAPACITR 1 MF 100V CER MONO 651 20%		8141-100-651-105M
C 18	0086013	CAPACITR 22 MF 25V SOLID TANT PCL 10%		T362C226K025AS
C 19	0086013	CAPACITR 22 MF 25V SOLID TANT PCL 10%		T362C226KC25AS
C 20	0C811C1	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 21	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 22	0081101	CAPACITR 1 MF 50V CER MONO 20%	72982	8131-050-651-105M
C 23	0C81210	CAPACITR .01 MF 50V CER MONO X7R 10%	72982	8121-050-X7R-103K
C 24	0070552	CAPACITR .002 MF 1KV CER DISC Z5U 20%	71590	CD202
C 25	0170263	CAPACITR 100 MF 20V		672D1C7HC2CCE5C
C 26	0C8C139	CAPACITR .1 MF 50V CER MONO -20%+80%	72982	8131-050-651-104Z
C 27	0070561	CAPACITR .005 MF 1KV CER DISC Z5U 20%	71590	CD5022
C 28	0089644	CAPACITR 1000 MF 20V		673D1CEHC2CJE5C
C 29	C17C263	CAPACITR 100 MF 20V		672D1C7HC2CCE5C
C 30	0081995	CAPACITR .001 MF 100V CER MONO X7R 10%	72982	8121-100-X7R-102K
C 31	0080149	CAPACITR 4.7 MF 20V SOLID TANT PCL 20%	80183	196D475X0C2CJE3
C 32	0170264	CAPACITR 1 MF 100V CER MONO 651 20%		8141-100-651-105M
CR 1	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 2	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 3	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR 4	0071142	DIODE 1N4154 SIL 25V 150MA	80368	1N4154
CR 5	0C83986	DIODE 1N4746A SI ZEN 18V 5% 1W	04713	1N4746A
CR 6	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 7	0171572	THYRISTOR SCR 200PRV 25A RMS		C12SE5
CR 8	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 9	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 10	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 11	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 12	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 13	0089679	DIODE 80SQ030 SIL 30V 8A SCHOTTKY		8CSQC3C
CR 14	0071143	DIODE 1N4735A SI ZEN 6.2V 5% 1W	04713	1N4735A
CR 15	0071111	DIODE 1N459A SIL 175V 40MA	80368	1N459A
CR 16	0082901	LAMP LED GRN .190 DIA .180 LNG 2.3V 20MA	31718	FLV34C
CR 17	0079488	DIODE 1N5302 CURRENT REGULATOR 1.5MA	04713	1N53C2
CR 18	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 19	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 20	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 21	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
CR 22	0071122	DIODE 1N914 SIL 75V 75MA	80368	1N914
CR 23	0C89681	RECTIFIER ASSY 200V 10A FAST REC.20C NSC		VJ24EX
CR 24	0078714	DIODE 1N4744A SI ZEN 15V 5% 1W	04713	1N4744A
CR 25	0071111	DIODE 1N459A SIL 175V 40MA	80368	1N459A
CR 26	0082901	LAMP LED GRN .19C DIA .18C LNG 2.3V 20MA	31718	FLV34C
CR 27	0078274	DIODE 1N4002 SIL 100V 1A	04713	1N4002
J 1	0170255	CONN RECT PIN HEADER PC 10 CIRCUIT RED		1-380551-2
L 1	0078841	INDUCTOR 4.7 MH MIN SHLD ENCAP 10%	72259	WEE-4700
L 2	0220936	COIL ASSY 420 UHY SER 465C		3443-04
L 3	0CE5688	INDUCTOR 1.5 UH FERRITE 16.2 A PC MT		6310-6
L 4	0220936	COIL ASSY 420 UHY SER 465C		
L 5	0089683	INDUCTOR 50 UH UNSHLD 10%		

TRANSMITTER +5.2V/+12V POWER SUPPLY PCB ASSEMBLY - 220917
(AC/DC VERSION ONLY)

REF DESIG PREFIX: 4653A-A11

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
Q 1	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 2	0089670	TRANSSTR IRF230 FET N-CHNL MOS POWER		IRF230
Q 3	0089670	TRANSSTR IRF230 FET N-CHNL MOS POWER		IRF230
Q 4	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 5	0077148	TRANSSTR 2N3251 PNP SIL	04713	2N3251
Q 6	0089669	TRANSSTR IRF132 FET N-CHNL MOS POWER		IRF132
Q 7	0080824	TRANSSTR 2N5415 PNP SIL	04713	2N5415
Q 8	0081633	TRANSTR MPS-L51 PNP SIL	04713	MPS-L51
Q 9	0081633	TRANSTR MPS-L51 PNP SIL	04713	MPS-L51
Q 10	0078215	TRANSSTR 2N5089 NPN SIL	04713	2N5089
Q 11	0080824	TRANSSTR 2N5415 PNP SIL	04713	2N5415
R 1	0085551	POT 5K OHM 1/2W CER 3/8 SQ HOR ADJ 20T	73138	66XR5K
R 2	0072068	RESISTOR 39K OHM 1/4W 10% COMP	01121	RCR07G393KS
R 3	0083902	RESISTOR 3.01K OHM RN55C 1% MTL FLM		RN55C3011F
R 4	0087193	POT 1K OHM 1/2W CER 3/8 SQ HOR ADJ 20T		MT4Y1C2
R 5	0083898	RESISTOR 2.15K OHM RN55C 1% MTL FLM		RN55C2151F
R 6	0071993	RESISTOR 3.9K OHM 1/4W 10% COMP	01121	RCR07G392KS
R 7	0072026	RESISTOR 10K OHM 1/4W 10% COMP	01121	RCR07G103KS
R 8	0083881	RESISTOR 866 OHM RN55C 1% MTL FLM		RN55C8660F
R 9	0083907	RESISTOR 4.22K OHM RN55C 1% MTL FLM		RN55C4221F
R 10	0074714	RESISTOR 3.3K OHM 1/4W 5% COMP	01121	RCR07G332JS
R 11	0078110	RESISTOR 180 OHM 1/4W 5% COMP	01121	RCR07G181JS
R 12		NOT ASSIGNED		
R 13	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 14	0071867	RESISTOR 50 OHM 3W WW 5%	24681	VAL3
R 15	0087584	RESISTOR .10 OHM 3W 1%		RS-2C .10 OHM 1%
R 16	0071989	RESISTOR 3.3K OHM 1/4W 10% COMP	01121	RCR07G332KS
R 17	0085551	POT 5K OHM 1/2W CER 3/8 SQ HOR ADJ 20T	73138	66XR5K
R 18	0072068	RESISTOR 39K OHM 1/4W 10% COMP	01121	RCR07G393KS
R 19	0083902	RESISTOR 3.01K OHM RN55C 1% MTL FLM		RN55C3011F
R 20	0087193	POT 1K OHM 1/2W CER 3/8 SQ HOR ADJ 20T		MT4Y1C2
R 21	0083898	RESISTOR 2.15K OHM RN55C 1% MTL FLM		RN55C2151F
R 22	0071951	RESISTOR 1.0K OHM 1/4W 10% COMP	01121	RCR07G1C2KS
R 23	0083901	RESISTOR 2.61K OHM RN55C 1% MTL FLM		RN55C2611F
R 24	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 25	0071966	RESISTOR 1.5K OHM 1/4W 10% COMP	01121	RCR07G152KS
R 26	0071867	RESISTOR 50 OHM 3W WW 5%	24681	VAL3
R 27	0076275	RESISTOR 22 OHM 1/4W 10% COMP	01121	RCR07G220KS
R 28	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 29	0071935	RESISTOR 680 OHM 1/2W 10% COMP	01121	RCR20G681KS
R 30	0071901	RESISTOR 180 OHM 1/4W 10% COMP	01121	RCR07G181KS
R 31	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 32	0071853	RESISTOR 27 OHM 1/4W 10% COMP	01121	RCR07G270KS
R 33	0071853	RESISTOR 27 OHM 1/4W 10% COMP	01121	RCR07G270KS
R 34	0072002	RESISTOR 4.7K OHM 1/4W 10% COMP	01121	RCR07G472KS
R 35	0071918	RESISTOR 330 OHM 1/4W 10% COMP	01121	RCR07G331KS
R 36	0072064	RESISTOR 33K OHM 1/4W 10% COMP	01121	RCR07G333KS
R 37	0082128	RESISTOR 12.1K OHM RN60C 1% MTL FLM		RN60C1212F
R 38	0071853	RESISTOR 27 OHM 1/4W 10% COMP	01121	RCR07G270KS
R 39	0083902	RESISTOR 3.01K OHM RN55C 1% MTL FLM		RN55C3011F
R 40	0079713	RESISTOR 2.00K OHM RN55C 1% MTL FLM		RN55C2001F
R 41	0083902	RESISTOR 3.01K OHM RN55C 1% MTL FLM		RN55C3011F
R 42	0071831	RESISTOR 5.6 OHM 1/2W 10% COMP	01121	RCR20G5R6KS
R 43	0079085	RESISTOR 100 OHM 3W WW 5%	24681	VAL-3
R 44	0071862	RESISTOR 47 OHM 1/4W 10% COMP	01121	RCR07G470KS
R 45	0071907	RESISTOR 220 OHM 1/4W 10% COMP	01121	RCR07G221KS
R 46	0071939	RESISTOR 680 OHM 1/2W 10% COMP	01121	RCR20G681KS
T 1	0220933	TRANSFORMR PWR SWITCHING SEE 4650		
TP 1	0076490	JACK TEST BLUE	74970	105-810
TP 2	0076490	JACK TEST BLUE	74970	105-810
TP 3	0076490	JACK TEST BLUE	74970	105-810
TP 4	0076490	JACK TEST BLUE	74970	105-810
U 1	0085993	IC VLTG RGLTR/PWM MOD 70C 16L-DIP		SG3524
U 2	0085993	IC VLTG RGLTR/PWM MOD 70C 16L-DIP		SG3524
U 3	0086265	IC OP AMP FMOS 8L-TO5 70C COMP		CA3140T
U 4	0083806	IC TIMER 8L-DIP	18324	NE555N

TRANSMITTER FRONT PANEL ASSEMBLY - 304122

REF DESIG PREFIX: 4653A-A12

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
3	0089611	PUSHBUTTON BLACK FOR SA PN 89610		B3C5BL
A 1	0252722	PWB ASSY FRONT PANEL XMTR MDL 4653		
A 2	0252741	PWB ASSY FLEX CIRCUIT AUTO RATE SWITCH		
W 1	0252816	CABLE ASSY,DS1/1C/2 OUTPUT XMTR MDL 4653		
W 2	0252756	FLEX CKT ASSY AUX INTFC XMTR MDL 4653		
W 3	0252783	CABLE ASSY, FRONT PNL I/O BERTS SER 4650		

TRANSMITTER FRONT PANEL PCB ASSEMBLY - 252722

REF DESIG PREFIX: 4653A-A12A1

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
CR 1	0171535	LAMP LED GRN .115 DIA..135 LNG 2.5V 30MA		HLMP-1523
J 1	0171548	CONN HEADER DBL ROW SIGHT 50-PIN + LATCH		3433-2202
J 2	0084930	CONN HEADER DBL ROW STRAIGHT 20-PIN PC	00779	1-87227-0
S 1	0252729	SWITCH ASY, OUTPUT SELECT		
S 2	0252728	SWITCH ASSY, DATA SELECT		
S 3	0171547	SWITCH PUSHB DPDT ALT ACT PC MT NONSHORT		K40352AA
S 4	0171547	SWITCH PUSHB DPDT ALT ACT PC MT NONSHORT		K40352AA
S 5	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 6	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 7	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 8	0089610	SWITCH PUSHB DPDT MOM		K40152AA
S 9	0171547	SWITCH PUSHB DPDT ALT ACT PC MT NONSHORT		K40352AA
S 10	0171547	SWITCH PUSHB DPDT ALT ACT PC MT NONSHORT		K40352AA

TRANSMITTER FLEX CIRCUIT AUTO RATE SW PCB ASSEMBLY - 252741

REF DESIG PREFIX: 4653A-A12A2

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
J 1	0085182	CONN 20-PIN FEM DOUBLE ROW BOTTOM MT	00779	86418-1
S 1	0252730	SWITCH ASSY, AUTO RATE		

TRANSMITTER REAR PANEL ASSEMBLY - 252735
(AC VERSION ONLY)

REF DESIG PREFIX: 4653A-A13

REF DESIG		PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
	2	0252744	AC PWR WIRING HARNESS BERTS		
	4	0158002	FILTER,FAN		
	5	0158041	RETAINER,SCREEN,MODEL 4647		
	24	0079833	GUARD FINGER FAN	82877	20C4S
	26	0085868	INSULATOR MICA FOR TO-3 CASE		852600F011
	27	0252778	PWR REGULATOR WIRING HARNESS BERTS		
B	1	0076321	FAN 3 IN. SPRITE 115VAC 50/60 HZ	82877	SU2A5
T	1	0252727	TRANSFORMER,POWER BERTS		
U	1	0087844	IC VLTG RGLTR +1.2 TO +37V .8A TYP TO3		LM317K
U	2	0088335	IC VLTG RGLTR -1.2 TO -37V .8A TYP TO3		LM337K
U	3	0170316	IC VLTG RGLTR +1.2 TO +32V 5A TYP TO3		LM338K

TRANSMITTER REAR PANEL ASSEMBLY - 252745
(AC/DC VERSION ONLY)

REF DESIG PREFIX: 4653A-A13

REF DESIG		PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
	2	0252782	PWR WIRING HARNESS AC/DC BERTS		
	4	0158002	FILTER,FAN		
	5	0158041	RETAINER,SCREEN,MODEL 4647		
	24	0079833	GUARD FINGER FAN	82877	20045
A	1	0252781	PWB ASSY RECTIFIER & FILTER AC/DC BERTS		
B	1	0220351	FAN ASSY SERIES 465C		
T	1	0252727	TRANSFORMER,POWER BERTS		

TRANSMITTER RECTIFIER AND FILTER PCB ASSEMBLY - 252781
(AC/DC VERSION ONLY)

REF DESIG PREFIX: 4653A-A13A1

REF DESIG		PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
	1	0304823	PWB-RECTIFIER & FILTER-AC/DC-BERTS		
	2	0081453	FUS HLDR CLIP FOR 3AG CR 3AB PC MT 2 PIN	79963	798
	5	0077828	INSULATR THERMA-FILM FOR TO-3 TRANSISTOR	13103	43-03-4
C	1	0075417	CAPACITR .01 MF 150V CER DISC Z5V-40+60%	71590	DDM-103
C	2	0089646	CAPACITR 33 MF 100V		672D336H100EK5C
C	3	0089646	CAPACITR 33 MF 100V		672D336H1CCEK5C
C	4	0171550	CAPACITR 1600 MF 75V		3050FP162U075JM
C	5	0171550	CAPACITR 1600 MF 75V		3050FP162L075JM
C	6	0170264	CAPACITR 1 MF 100V CER MONO 651 20%		8141-100-651-105M
CR	1	0081865	DIODE 1N4995 SIL 200V 3A PC MOUNT	04713	1N4999
CR	2	0089680	RECTIFIER ASSY 200V 10A		PY2C-WIRE LEADS
CR	3	0089680	RECTIFIER ASSY 200V 10A		PY2C-WIRE LEADS
CR	4	0083986	DIODE 1N4746A SI ZEN 18V 5% 1W	04713	1N4746A
F	1	0071232	FUSE 5 AMP SLO BLO	75915	3AG 313005.
F	2	0071236	FUSE 10 AMP 250 VOLT	75915	3AB 314010.
J	1	0089690	CONN RECT SOCKET HEADER ASSY 3 CIRCUITS		350760-4
J	2	0082765	CONN RECT PIN HEADER PC BD 6 CIRCUIT	00779	1-380999-0
J	3	0087351	CONN RECT PIN HEADER PC BD 2 CIRCUIT		350539-2
L	1	0170266	INDUCTOR 47 UH CHOKE 4 AMPS		RL-1283-47
L	2	0170266	INDUCTOR 47 UH CHOKE 4 AMPS		RL-1283-47
Q	1	0085665	TRANSSTR IRF132 FET N-CHNL MOS POWER		IRF132
R	1	0072214	RESISTOR 4.7 MEG 1/4W 10% COMP	01121	RCR07G475KS

TRANSMITTER POWER WIRING HARNESS - 252751
(AC VERSION ONLY)

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
1	0086010	CONN CONTACT #18-22AWG FEM GOLD PLATE		60617-5
2	0089565	CONN CONTACT RECEPTACLE #18-22AWG		87027-3
3	0087429	PLUG KEYING FOR SA #87427		87116-2
P 1	0087046	CONN RECT SOC HOUSING FREE HANG 10 CIR		1-480285-0
P 2	0089674	CONN HEADER HOUSING 12 PIN SGL ROW		1-87025-1

TRANSMITTER POWER WIRING HARNESS - 220947
(AC/DC VERSION ONLY)

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
001	0086010	CONN CONTACT #18-22AWG FEM GOLD PLATE		60617-5
002	0089565	CONN CONTACT RECEPTACLE #18-22AWG		87027-3
003	0087429	PLUG KEYING FOR SA #87427		87116-2
P 001	0087046	CONN RECT SOC HOUSING FREE HANG 10 CIR		1-480285-0
P 002	0170256	CONN RECT SOC HOUSING 10 CIRCUIT RED		1-480285-2
P 003	0087352	CONN RECT SOC HOUSING POS LOCK 2 CIRCUIT		1-480720-0
P 004	0089674	CONN HEADER HOUSING 12 PIN SGL ROW		1-87025-1

TRANSMITTER ACCESSORY KIT - 304138

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
1	0256025	MODEL 4653A ERR RT XMTR OPR MNL		
2	0089672	CORD SET 3-WIRE #18 125V 9-FT W/RT ANG F		17746-YEL SHIELDED
3	0071223	FUSE 2 AMP	75915	3AG 312002.
4	0071229	FUSE 4 AMP	75915	3AG 312004.
5	0071232	FUSE 5 AMP SLO BLO	75915	3AG 313005.
6	0071236	FUSE 10 AMP 250 VOLT	75915	3AB 314010.
7	0071217	FUSE 1/2 AMP SLO BLO	75915	3AG 313.500
8	0087460	CONN CONTACT PIN FOR SA PN 87458		350547-2
9	0089689	CONN RECT PLUG HOUSING 3 CIRCUITS		1-480700-0

TRANSMITTER SERVICE ACCESSORY KIT - 304139

REF DESIG	PART NO.	DESCRIPTION	FSCM CODE	VENDOR PART NUMBER
1	0221035	PWB ASSY EXTENDER CARD MODEL 4652		
2	0254439	CARD PULLER		
3	0256026	MODEL 4653A ERR RT XMTR MAINT MNL		

CHAPTER 7
DIAGRAMS

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*AC Version Only
**AD/DC Version Only

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*AC Version Only
**AC/DC Version Only

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*AC Version Only
**AC/DC Version Only

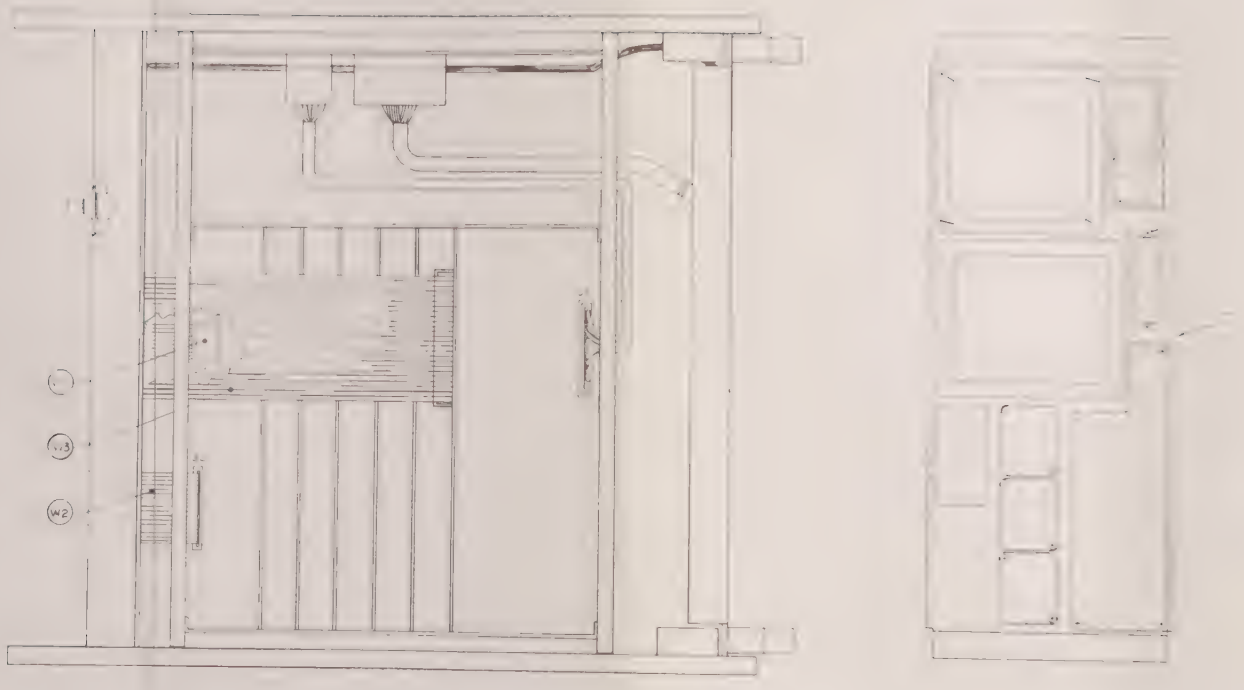


Figure 7.1. Transmitter Chassis Assembly Cable Installation Reference (AC Version Only), (Sheet 1 of 3)

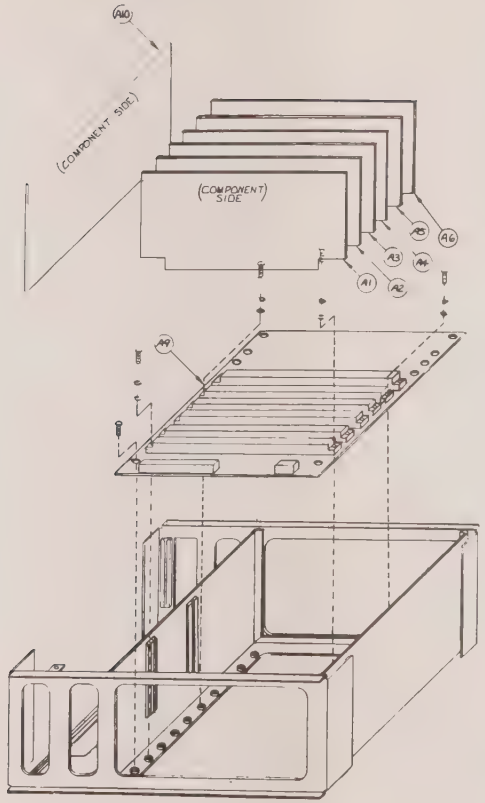


Figure 7.1. Transmitter Chassis Assembly Installation Reference (AC Version Only) (Sheet 2 of 3)

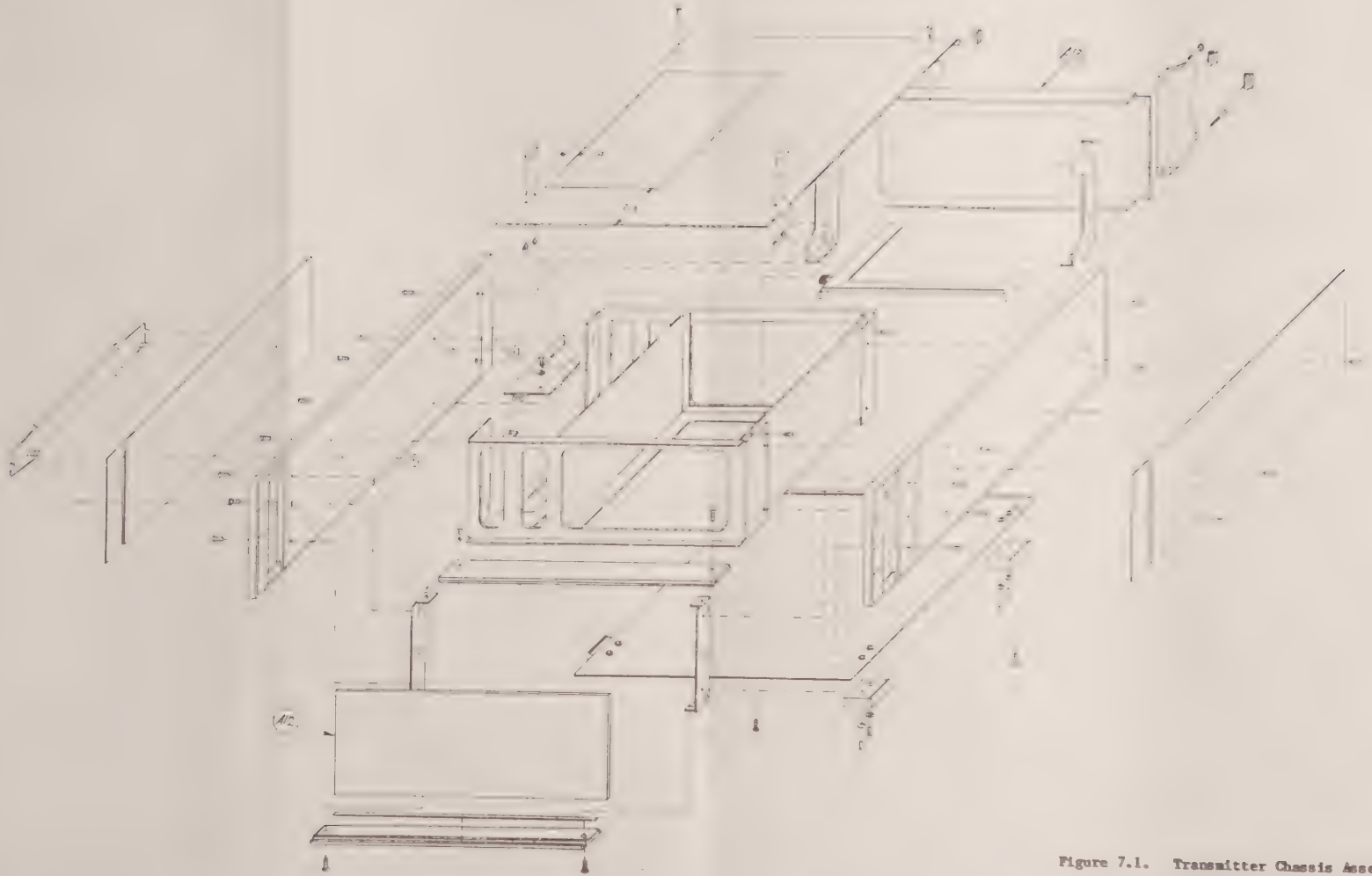


Figure 7.1. Transmitter Chassis Assembly Mechanical Layout (AC Version Only), (Sheet 3 of 3)

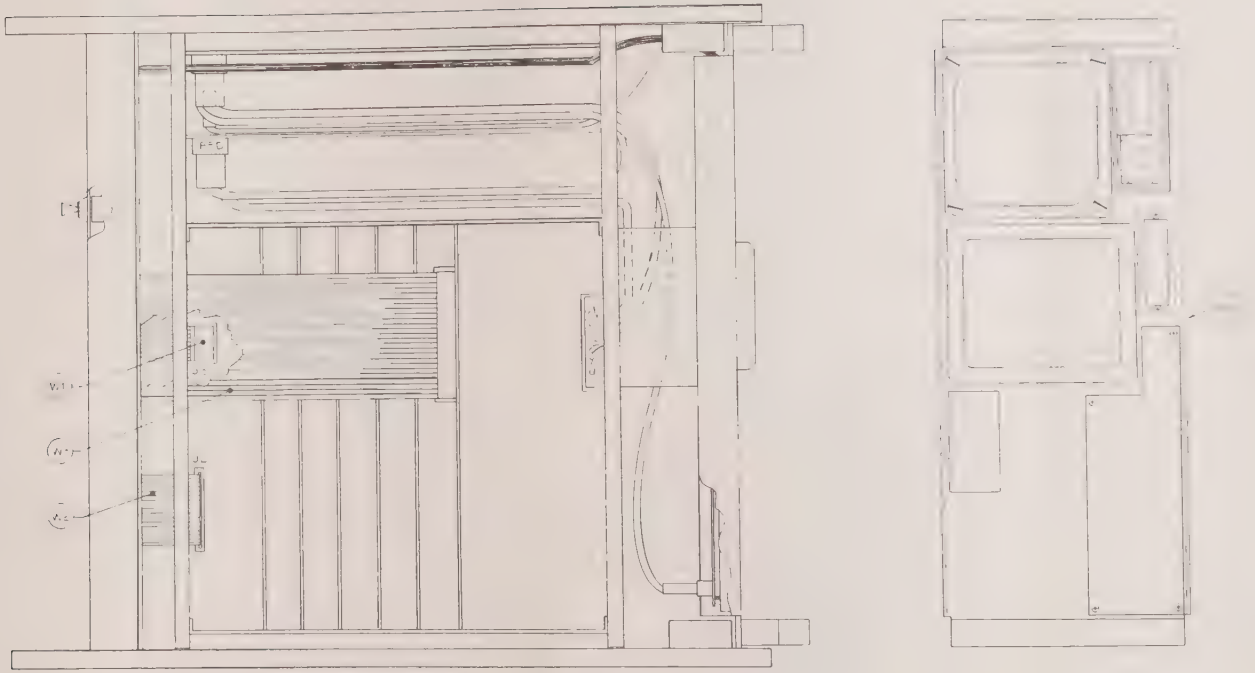


Figure 7.2. Transmitter Chassis Assembly Cable Installation Reference (AC/DC Version Only) (Sheet 1 of 3)

Figure 7.2. Transmitter Chassis Assembly Installation Reference (AC/DC Version Only) (Sheet 2 of 3)

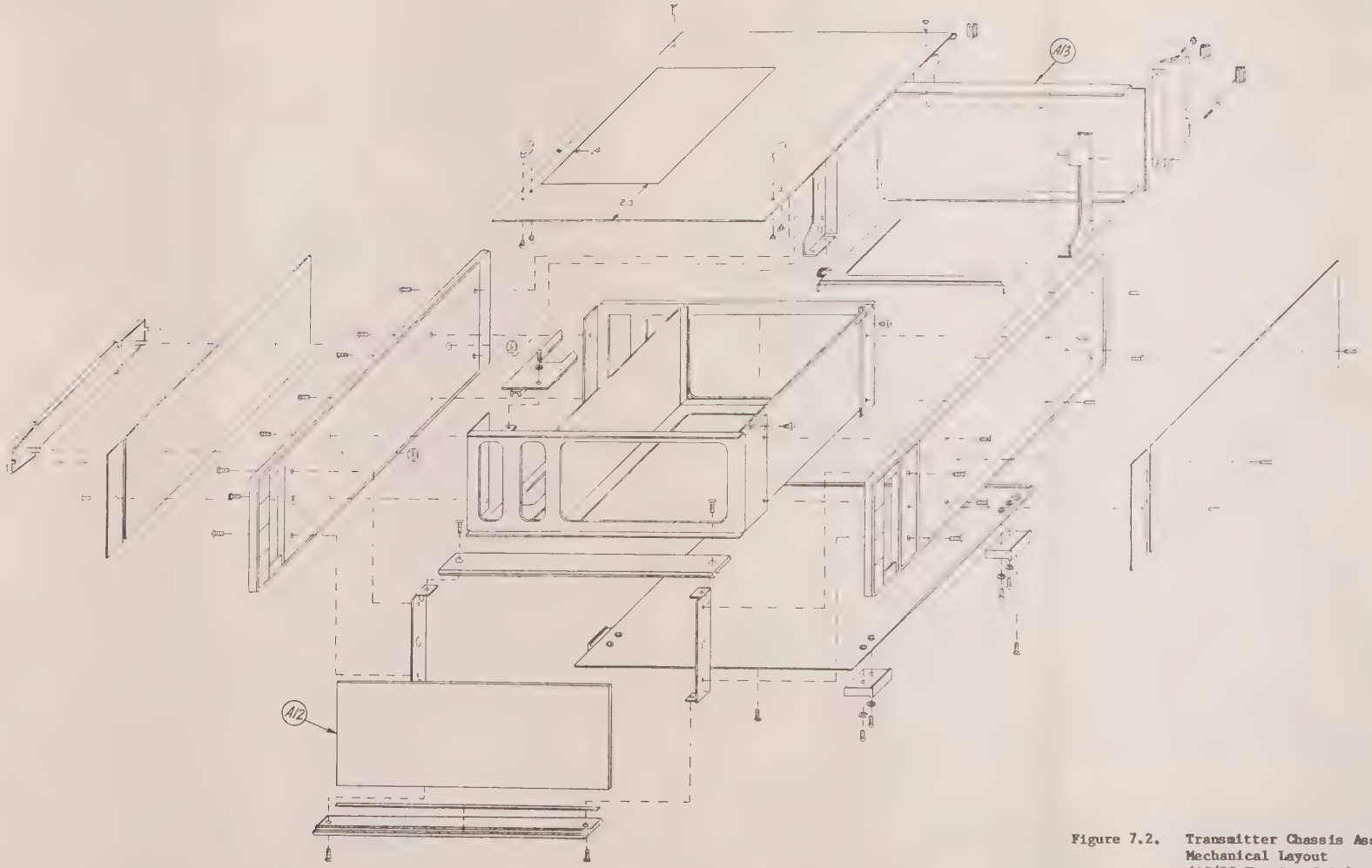


Figure 7.2. Transmitter Chassis Assembly Mechanical Layout (AC/DC Version Only) (Sheet 3 of 3)

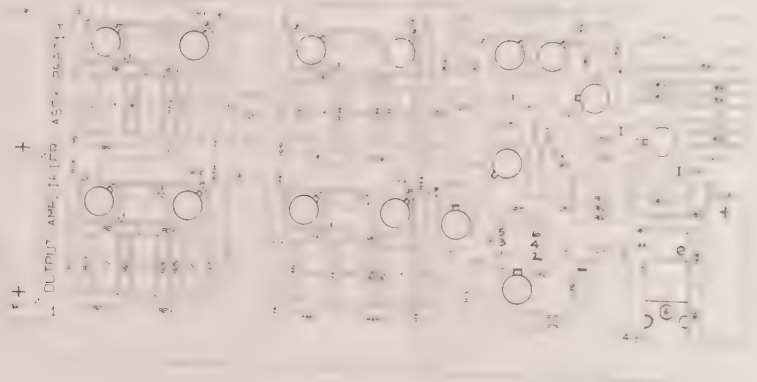


Figure 7.3. Transmitter Output Amplifier Assembly (A1), Component Location

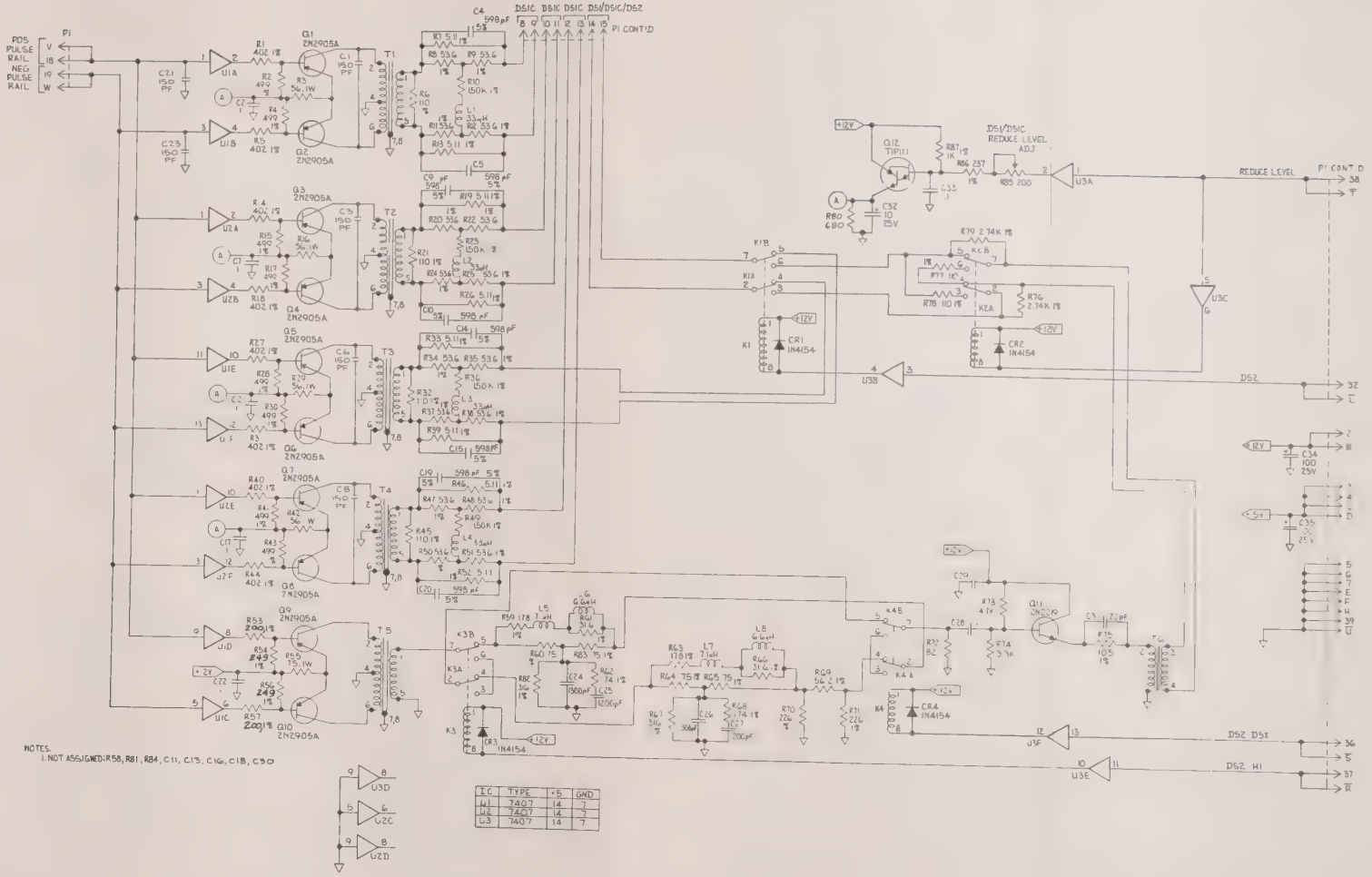


Figure 7.4. Transmitter Output Amplifier Assembly (A1), Schematic

252711B
35G037Z

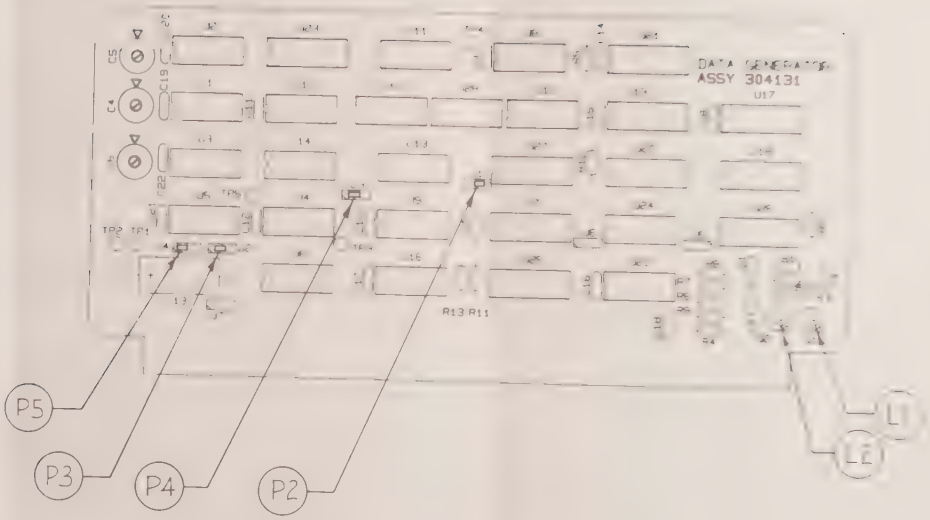
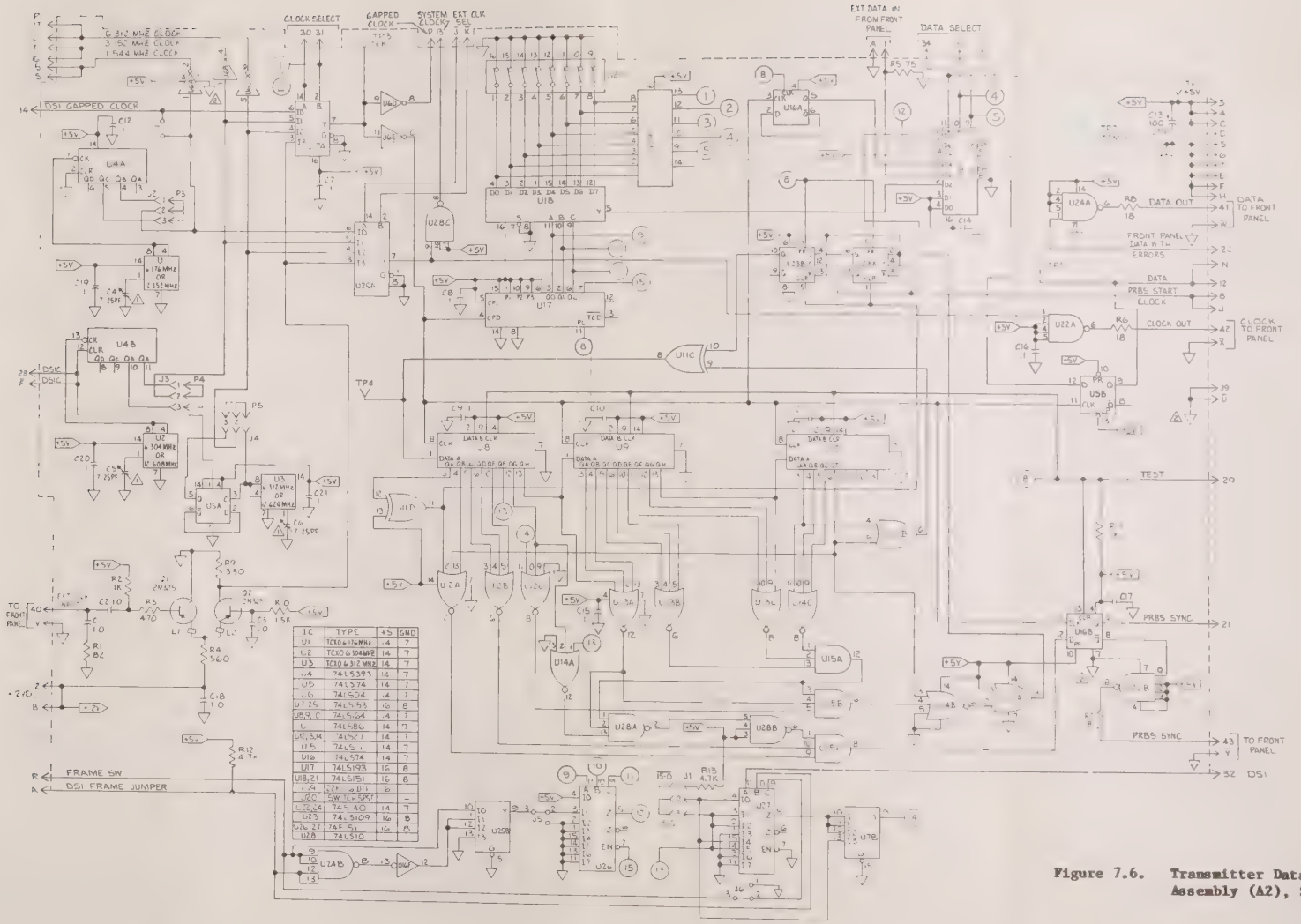
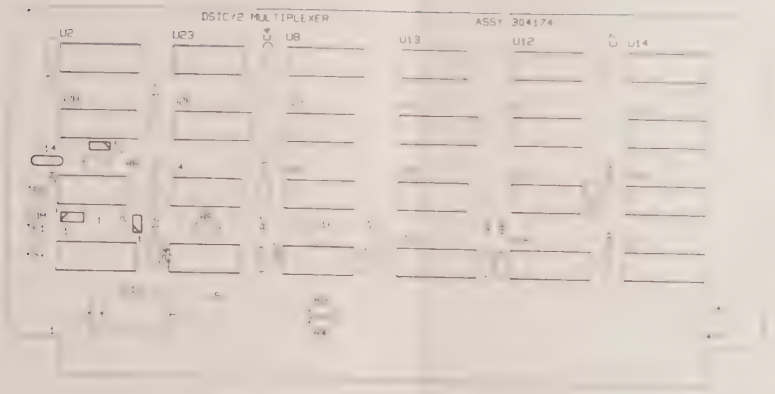


Figure 7.5. Transmitter Data Generator Assembly (A2), Component Location



IC	TYPE	+5	GND
U1	TCXO 6.176MHz	14	7
U2	TCXO 6.304MHz	14	7
U3	TCXO 6.312 MHz	14	7
U4	74LS393	14	7
U5	74LS74	14	7
U6	74LS04	14	7
U7,26	74LS153	16	8
U8,9,C	74LS04	14	7
U	74LS86	14	7
U10,14	74LS27	14	7
U15	74LS	14	7
U16	74LS74	14	7
U17	74LS193	16	8
U18,21	74LS151	16	8
U24	22K DIP	6	
J20	SW 7CH SPST		
U22,24	74LS40	14	7
U23	74LS109	16	8
U26 27	74F51	16	8
U28	74LS10		

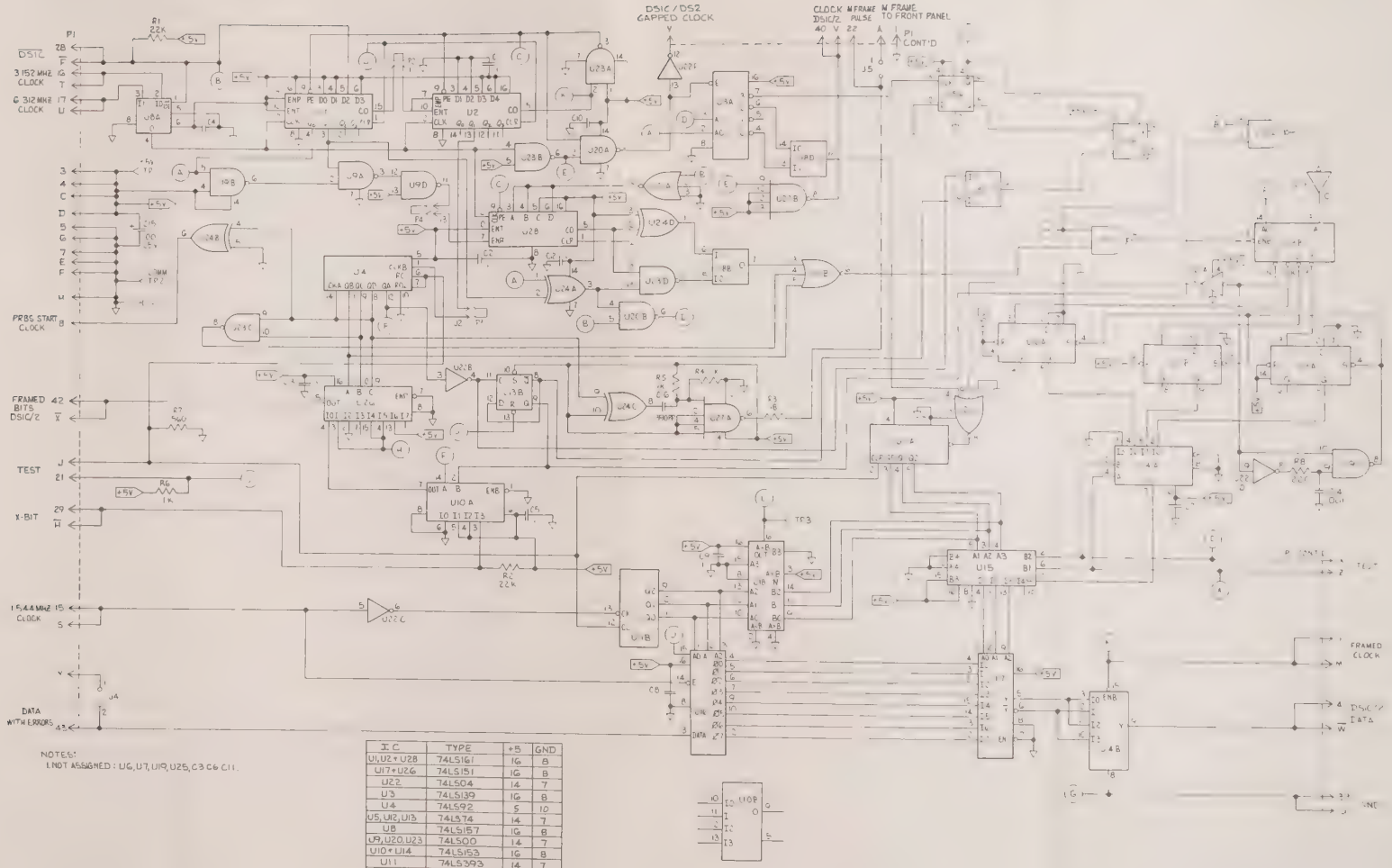
Figure 7.6. Transmitter Data Generator Assembly (A2), Schematic



NOTES:

1. THE FOLLOWING COMPONENTS SHOWN BUT NOT INSTALLED:
   TP1 AND TP2
2. REFERENCE DESIGNATION NOT ASSIGNED:
   U6, U7, U19, U25, C3, C61C11

Figure 7.7. **Transmitter Multiplexer Assembly (A3), Component Location**


DSIC/DS2 GAPPED CLOCK
CLOCK W FRAME W FRAME
DSIC/2 PULSE TO FRONT PANEL
P1 CONT'D
P1
DSIC
3.152 MHZ CLOCK
6.312 MHZ CLOCK
PRBS START CLOCK
FRAMED BITS DSIC/2
TEST
X-BIT
15.44 MHZ CLOCK
DATA WITH ERRORS
FRAMED CLOCK
DSIC DATA
TP3
U10A
U10B
U11B
U11C
U11D
U12A
U12B
U12C
U12D
U13B
U13C
U13D
U14A
U14B
U14C
U14D
U15
U16
U17
U18
U19
U20A
U20B
U21A
U21B
U21C
U21D
U22
U23A
U23B
U24A
U24B
U24C
U24D
U25
U26A
U26B
U26C
U26D
U27
U28
U3
U4
U5
U8A
U8B
U9A
U9B
U9C
U9D
R1 22K
R2 22K
R4
R5
R6 1K
R7 560
J1
J2
J3
J4
J5
J6
J7
J8
J9
J10
J11
J12
J13
J14
J15
J16
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J40

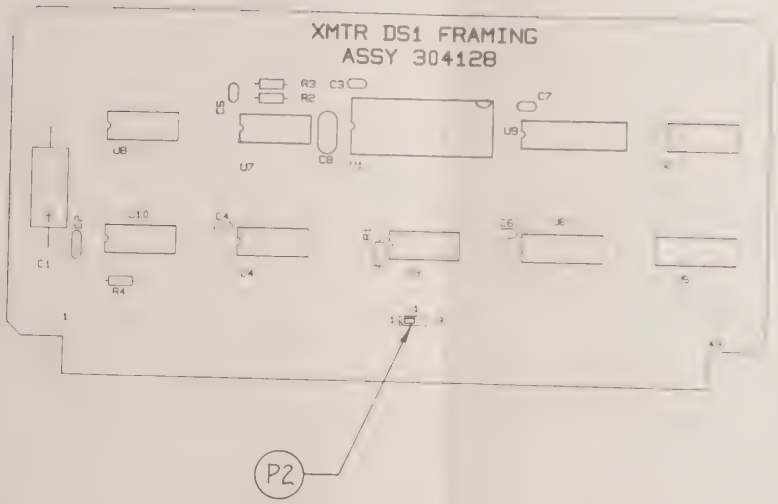
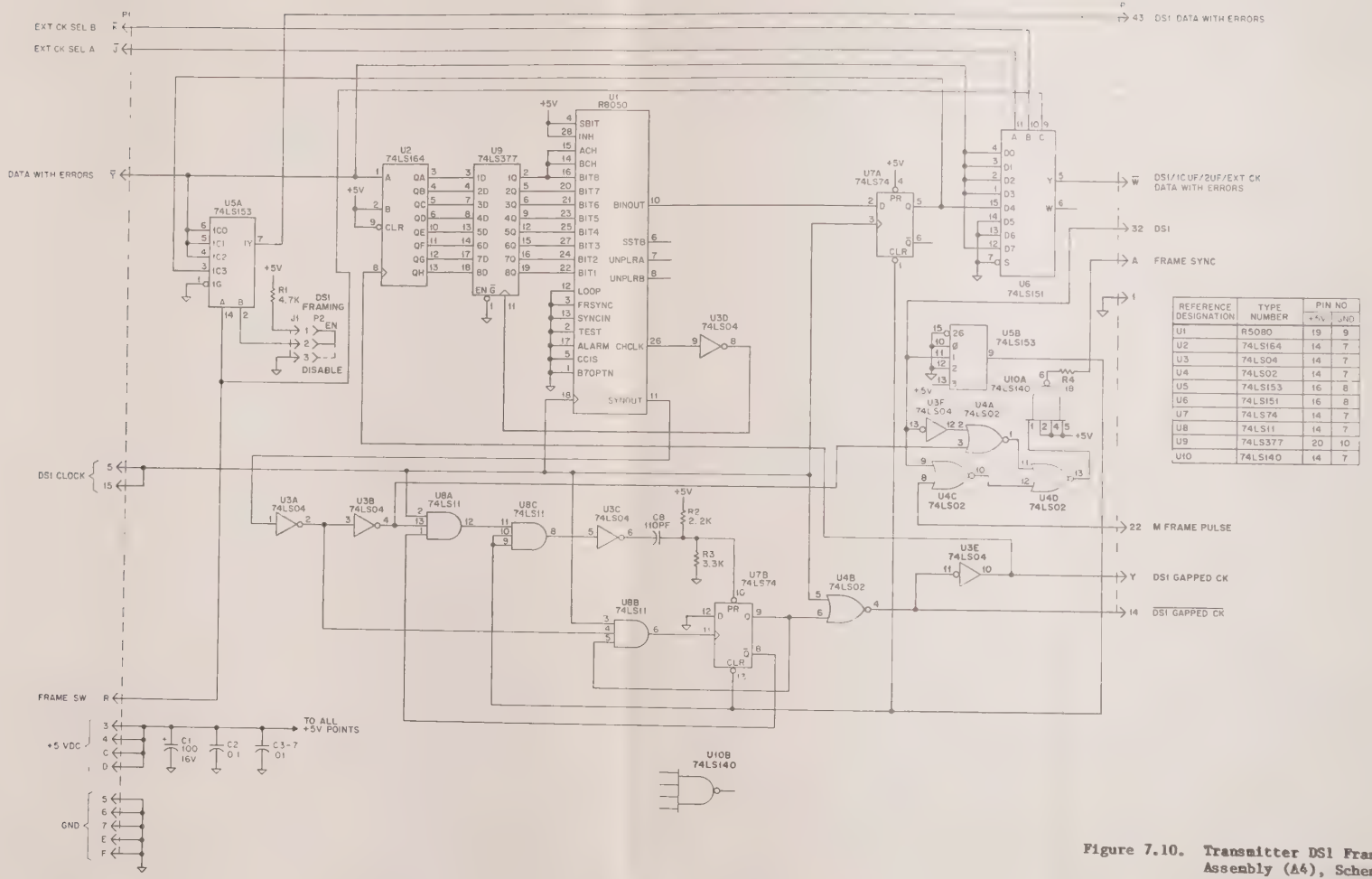


Figure 7.9. Transmitter DS1 Framing Assembly (A4), Component Location



REFERENCE DESIGNATION	TYPE NUMBER	PIN NO +5V	PIN NO GND
U1	R5080	19	9
U2	74LS164	14	7
U3	74LS04	14	7
U4	74LS02	14	7
U5	74LS153	16	8
U6	74LS151	16	8
U7	74LS74	14	7
U8	74LS11	14	7
U9	74LS377	20	10
U10	74LS140	14	7

Figure 7.10. Transmitter DS1 Framing Assembly (A4), Schematic

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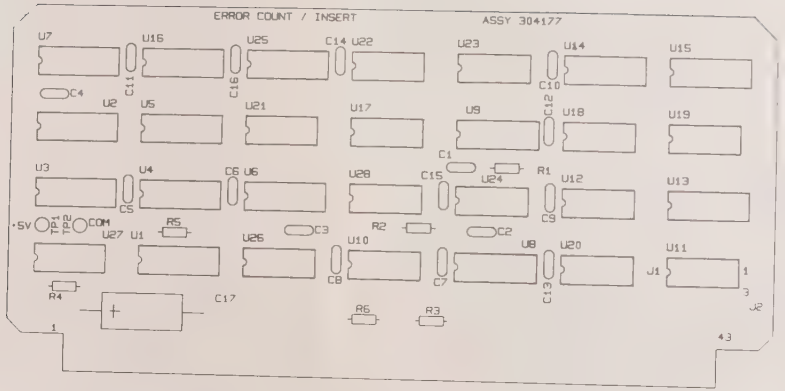
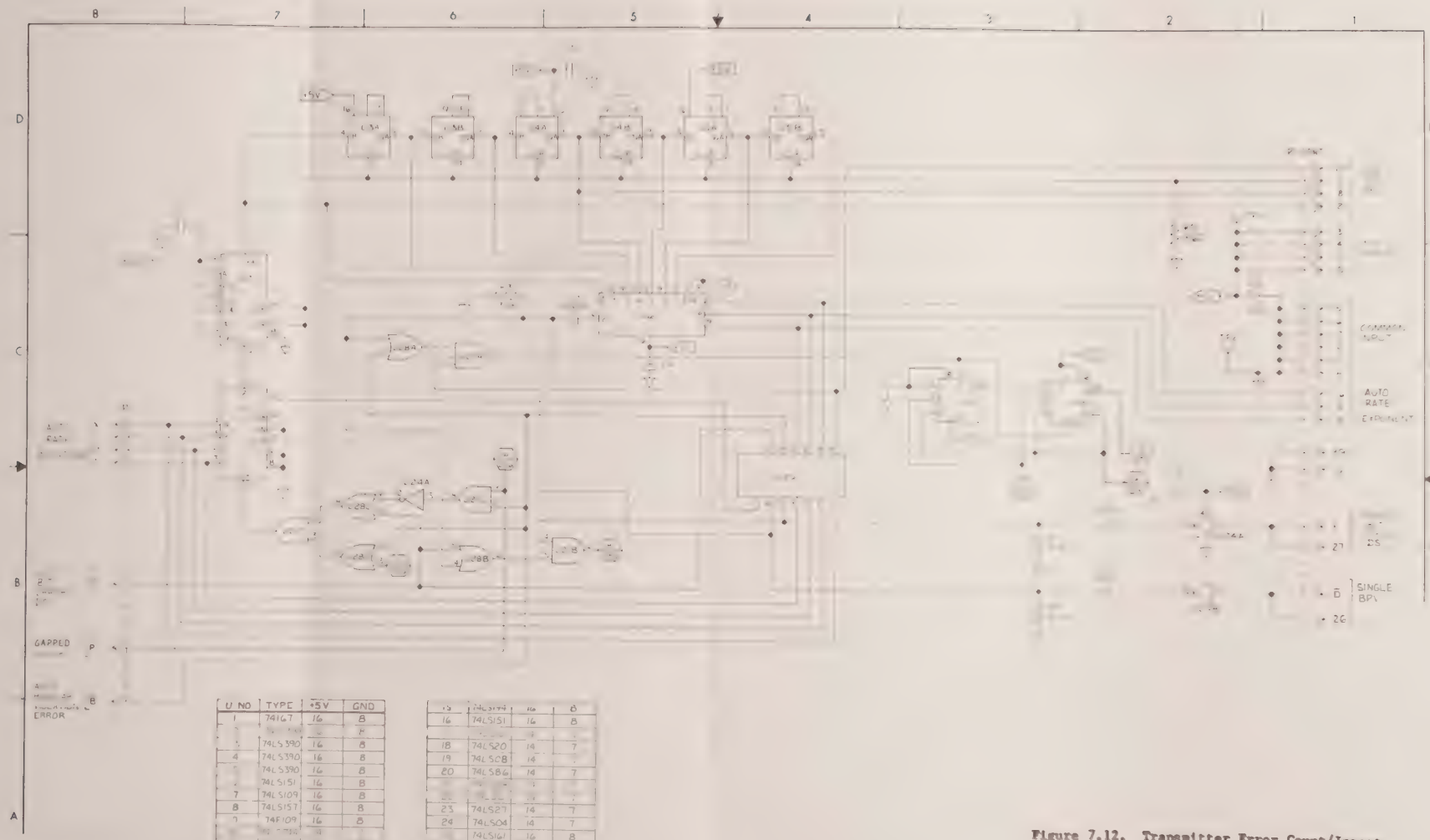
35G037Z



NOTES:

1. THE FOLLOWING COMPONENTS ARE SHOWN BUT NOT INSTALLED:
   TP1 & TP2

Figure 7.11. Transmitter Error Count/Insert Assembly (A5), Component Location



U NO	TYPE	+5V	GND
1	74LG7	16	8
2			
3	74LS390	16	8
4	74LS390	16	8
5	74LS390	16	8
6	74LS151	16	8
7	74LS109	16	8
8	74LS157	16	8
9	74F109	16	8
10			
11			
12			
13	74LS109	16	8
14	74LS194	16	8

15	74LS194	16	8
16	74LS151	16	8
17			
18	74LS20	14	7
19	74LS08	14	7
20	74LS86	14	7
21			
22			
23	74LS27	14	7
24	74LS04	14	7
25	74LS161	16	8
26	2.2KΩ	14	—
27	74S140	14	7
28	74LS32	14	7

304175
35G037Z

Figure 7.12. Transmitter Error Count/Insert Assembly (A5), Schematic (Sheet 1 of 2)

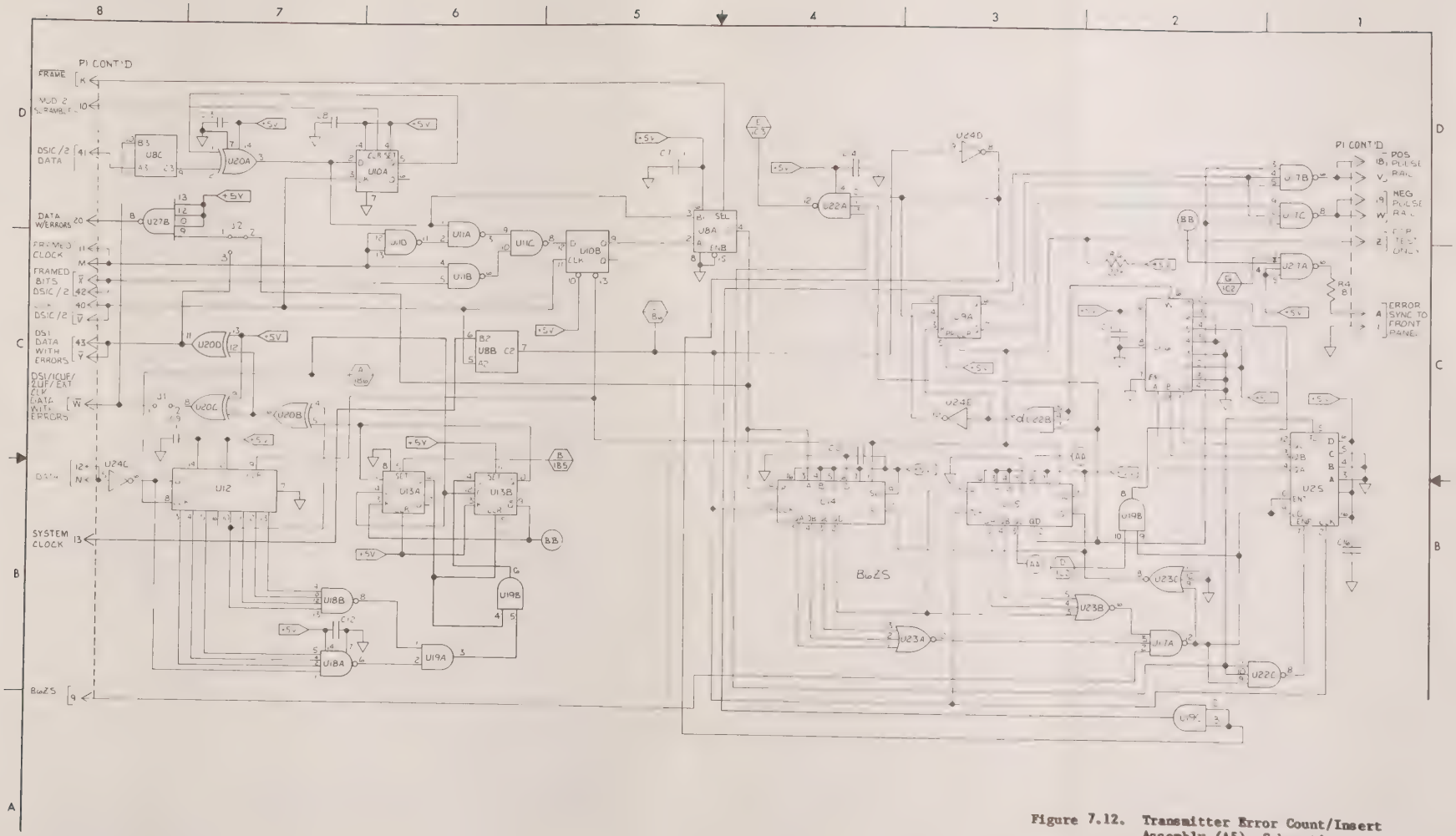


Figure 7.12. Transmitter Error Count/Insert Assembly (A5), Schematic (Sheet 2 of 2)

304175
35G037Z

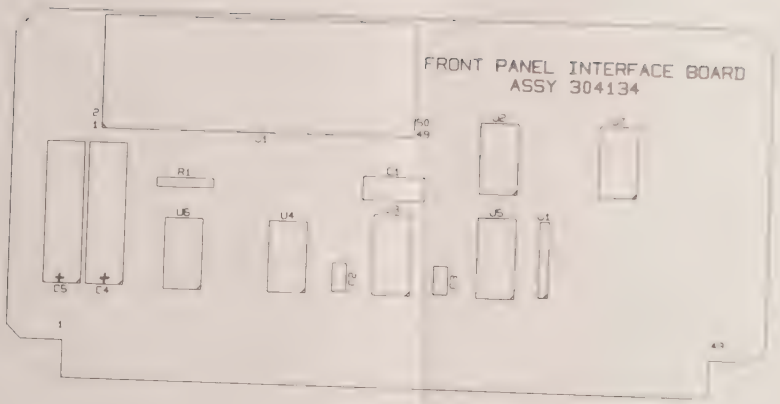


Figure 7.13. Transmitter Front Panel Interface Assembly (A6), Component Location

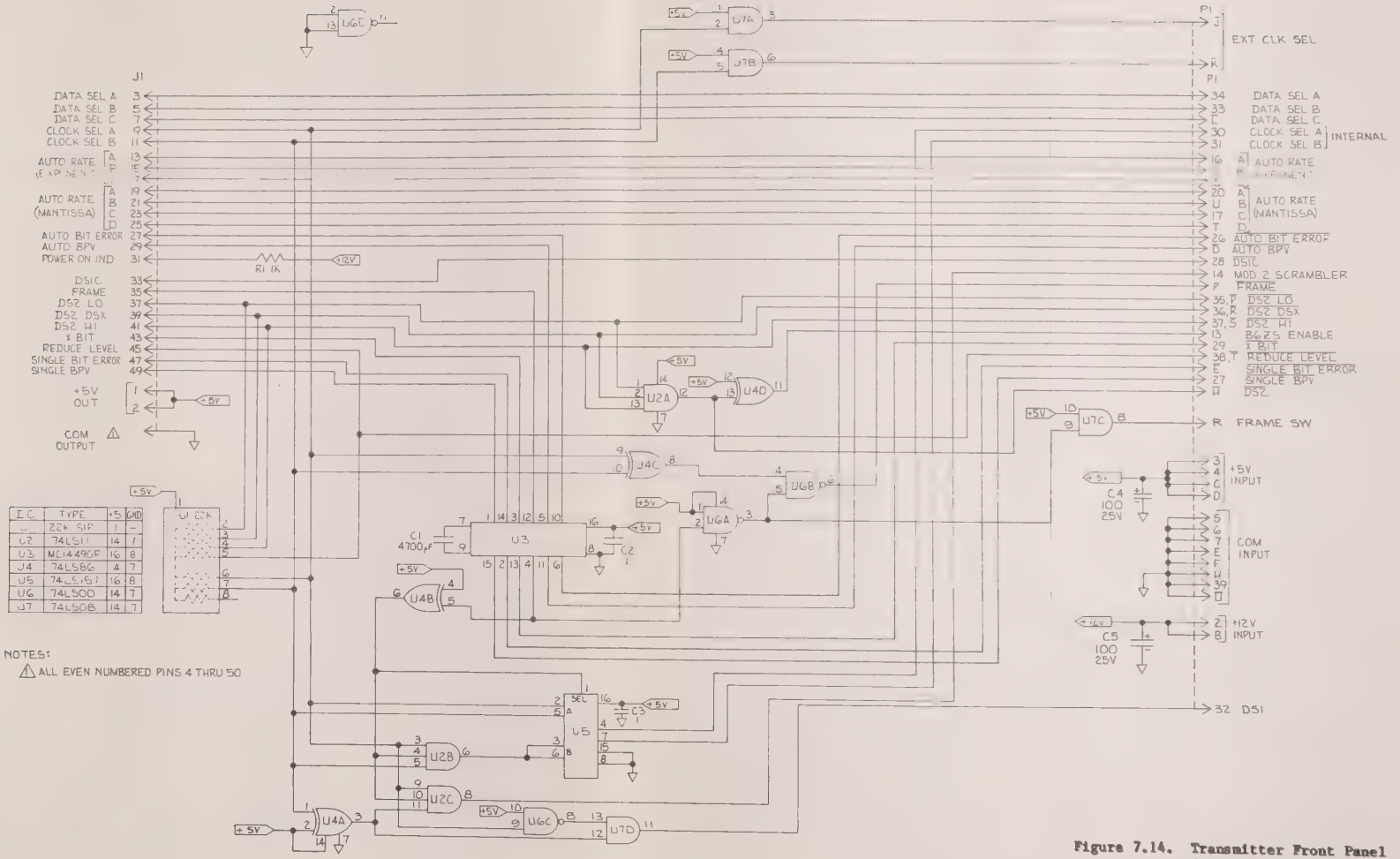


Figure 7.14. Transmitter Front Panel Interface Assembly (A6), Schematic

304132
35G037Z

Figure 7.15. Transmitter Motherboard Assembly (A9), Component Location

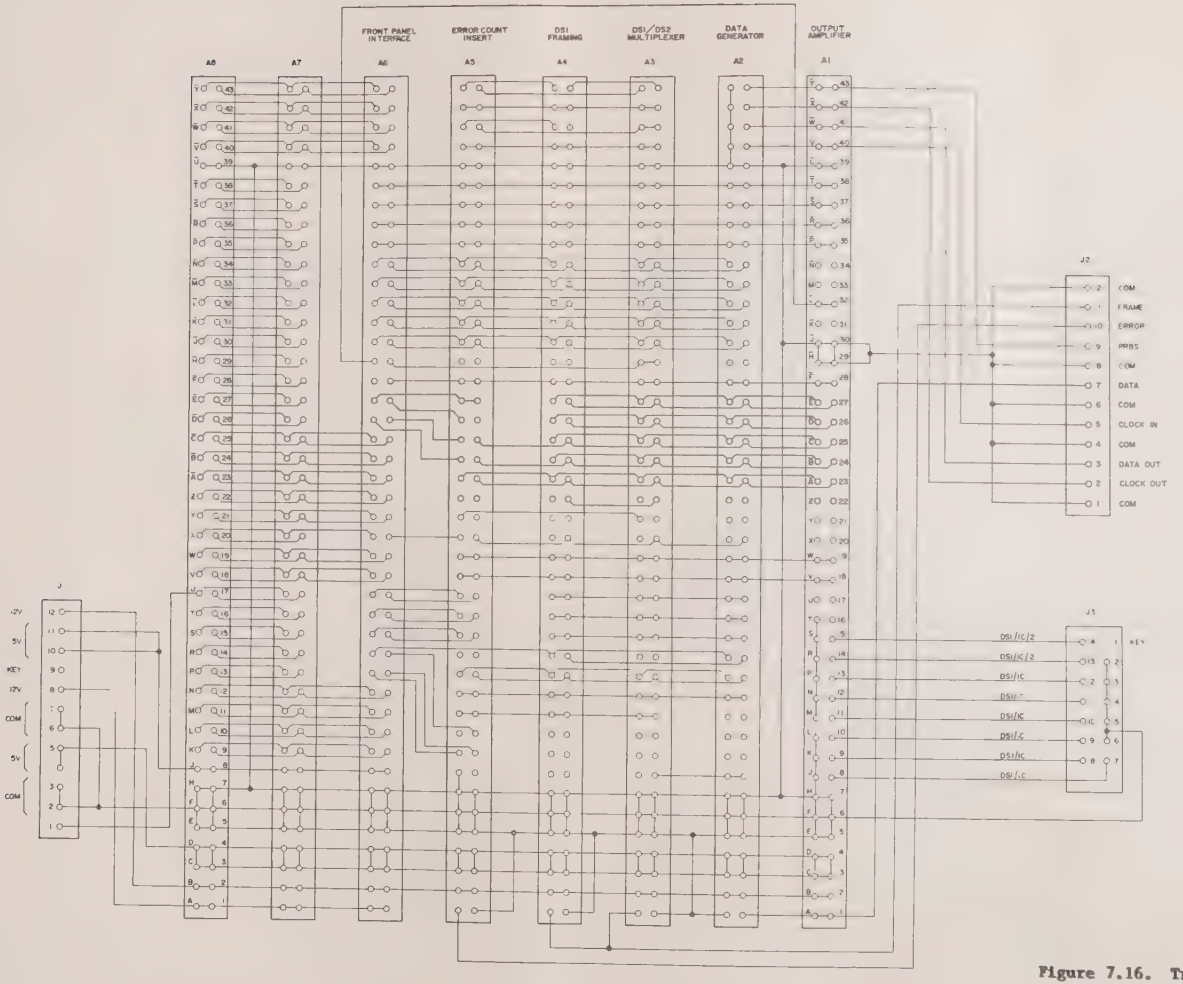


Figure 7.16. Transmitter Motherboard Assembly (A9), Schematic

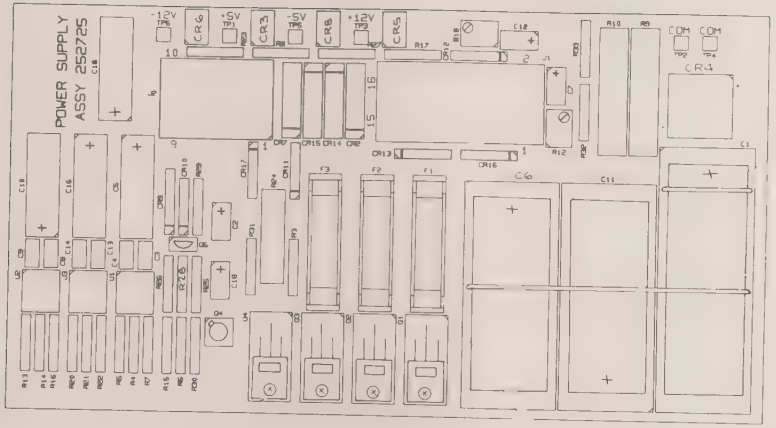


Figure 7.17. Transmitter Power Supply Assembly (A10) (AC Version Only), Component Location

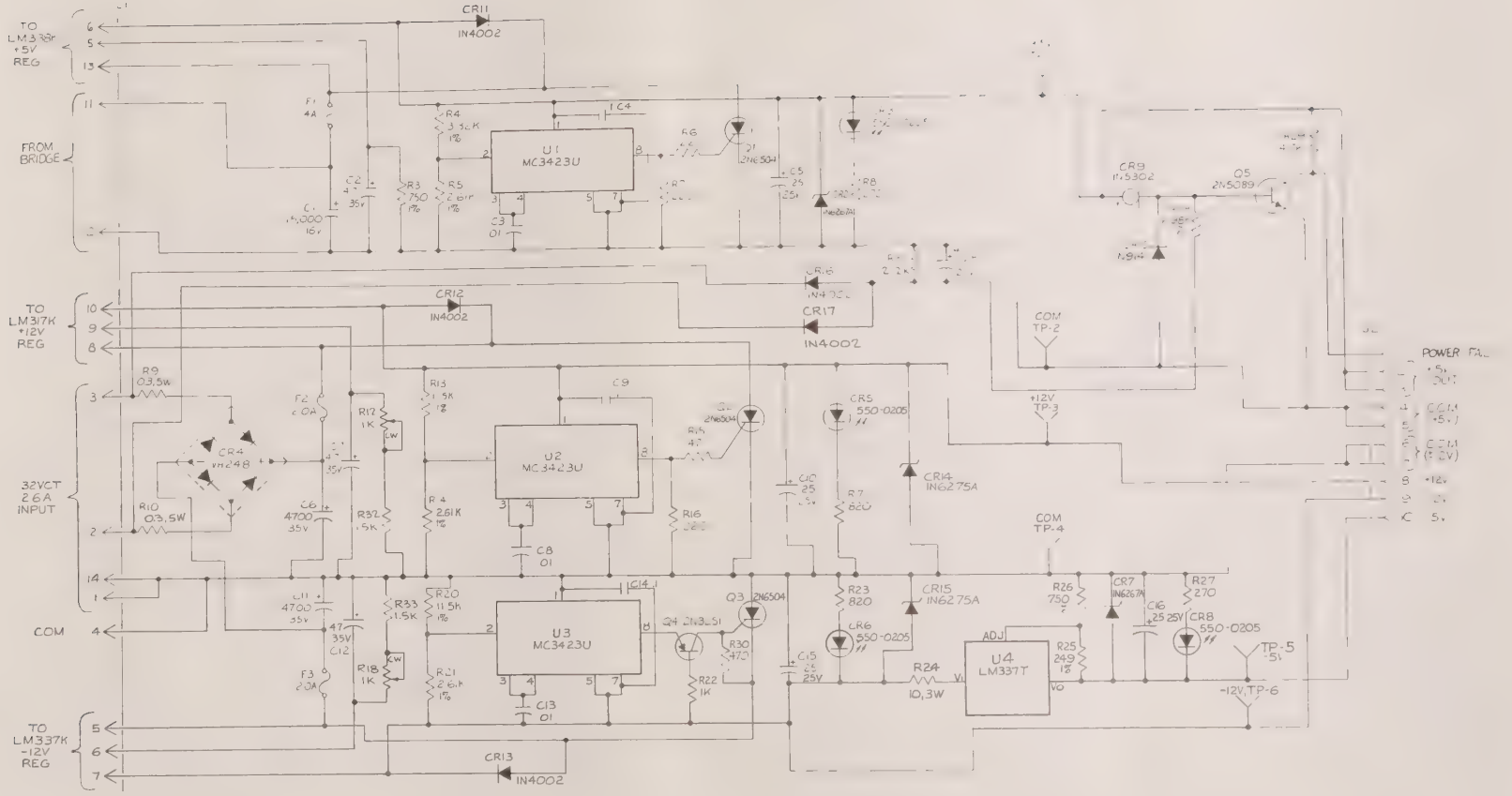


Figure 7.18. Transmitter Power Supply Assembly (A10) (AC Version Only), Schematic

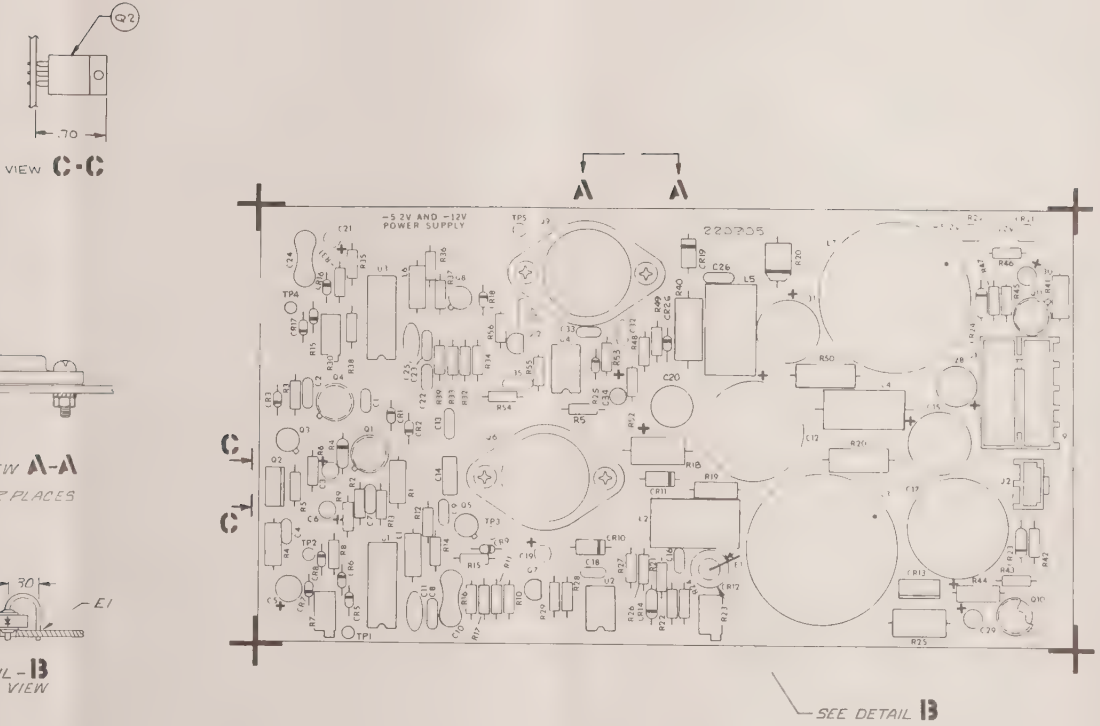


Figure 7.19. Transmitter -5.2V/-12V Power Supply Assembly (A10) (AC/DC Version Only), Component Location

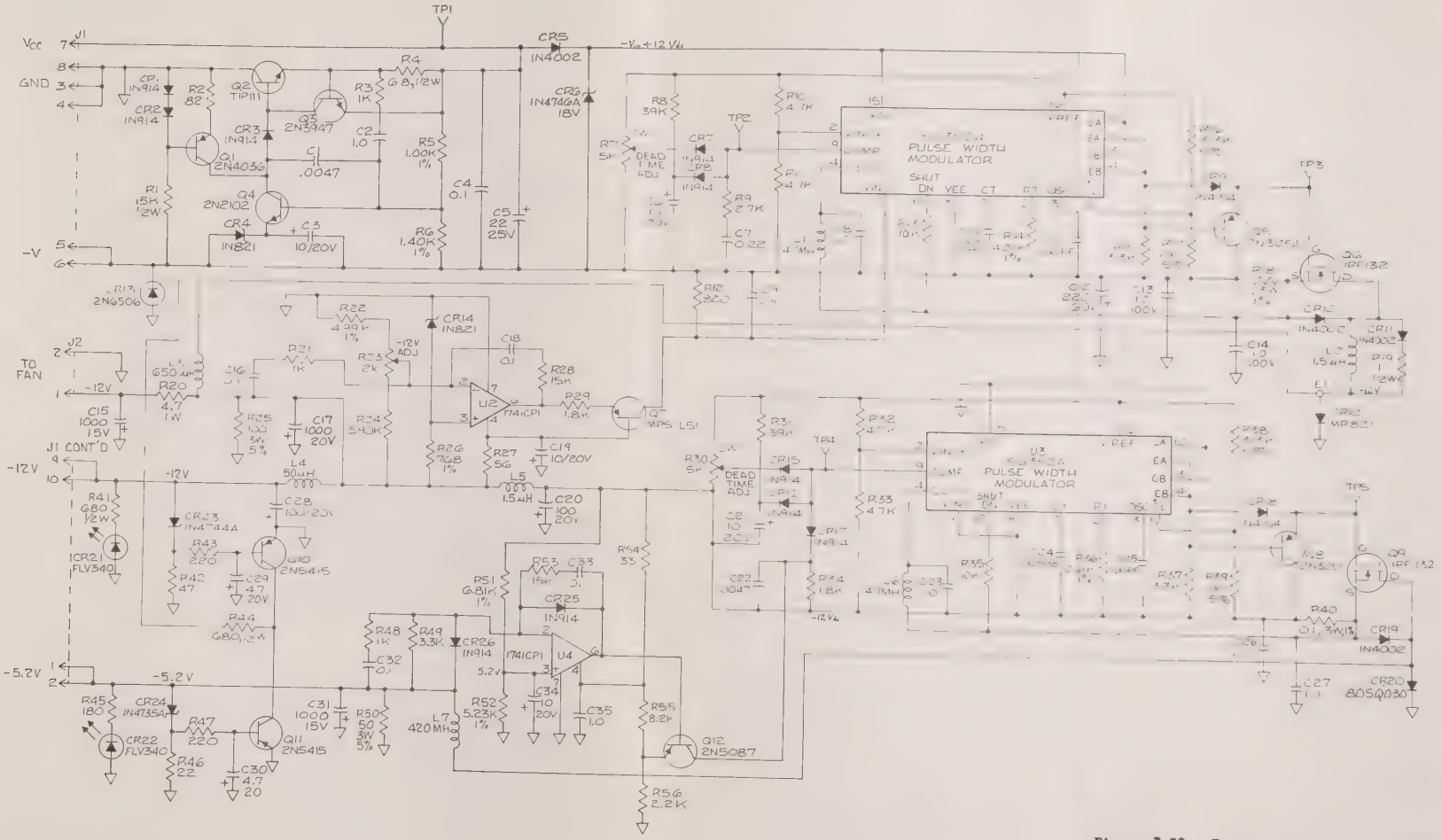
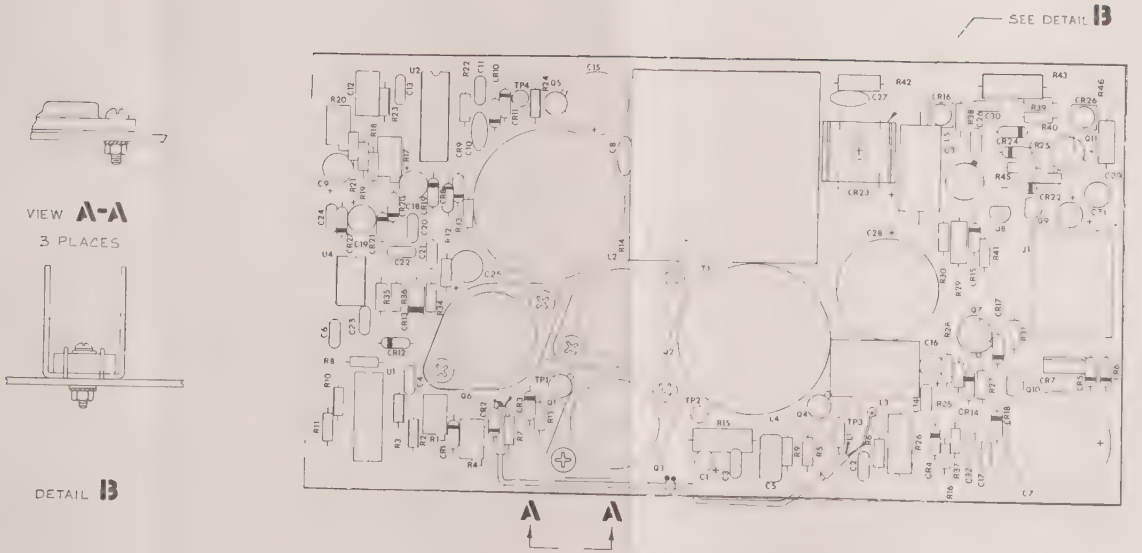


Figure 7.20. Transmitter -5.2V/-12V Power Supply Assembly (A10) (AC/DC Version Only), Schematic

220903B

35G037Z



NOTES:

1. REF DESIGNATIONS NOT USED: R12

Figure 7.21. Transmitter +5.2V/+12V Power Supply Assembly (A11) (AC/DC Version Only), Component Location

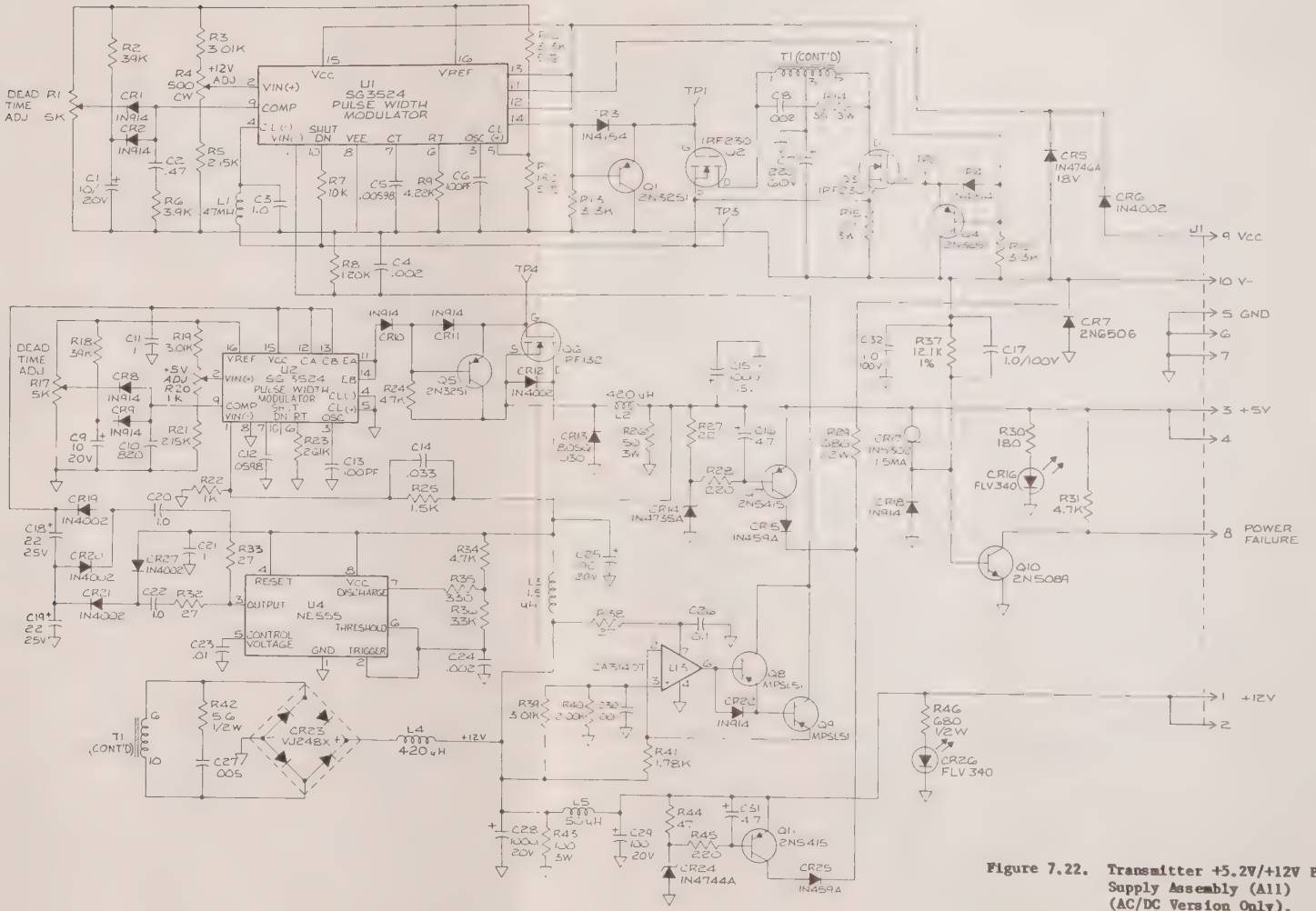


Figure 7.22. Transmitter +5.2V/+12V Power Supply Assembly (A11) (AC/DC Version Only), Schematic

220915L
35G037Z

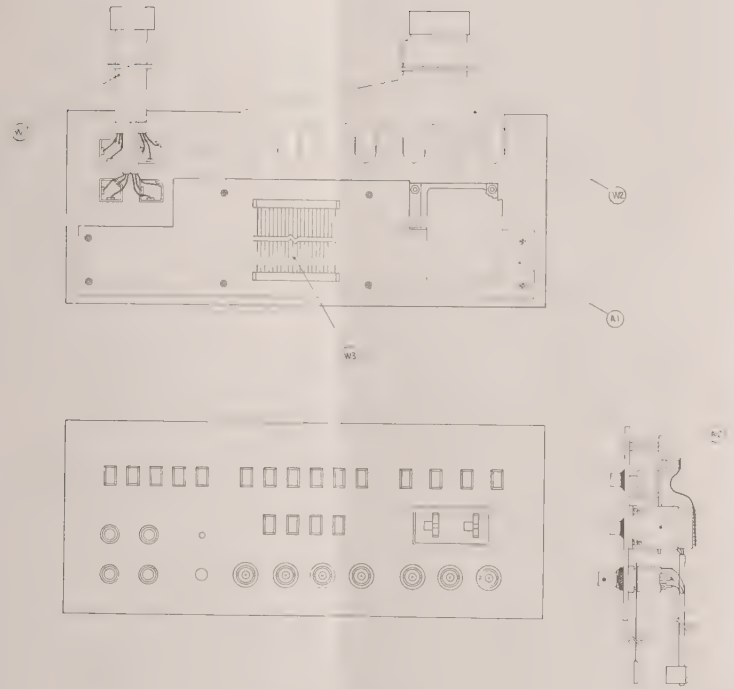


Figure 7.23. Transmitter Front Panel Assembly (A12), Cable Installation Reference

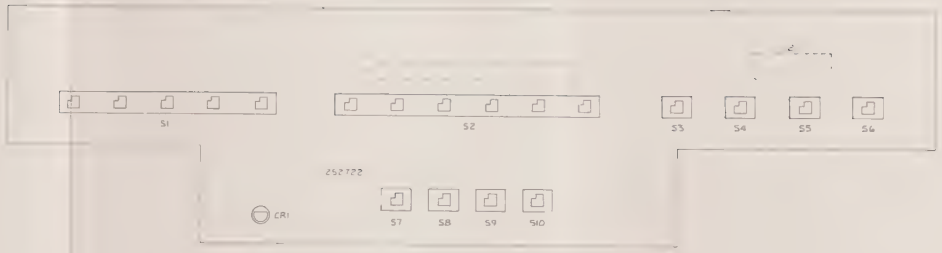


Figure 7.24. Transmitter Front Panel (A12A1), Component Location

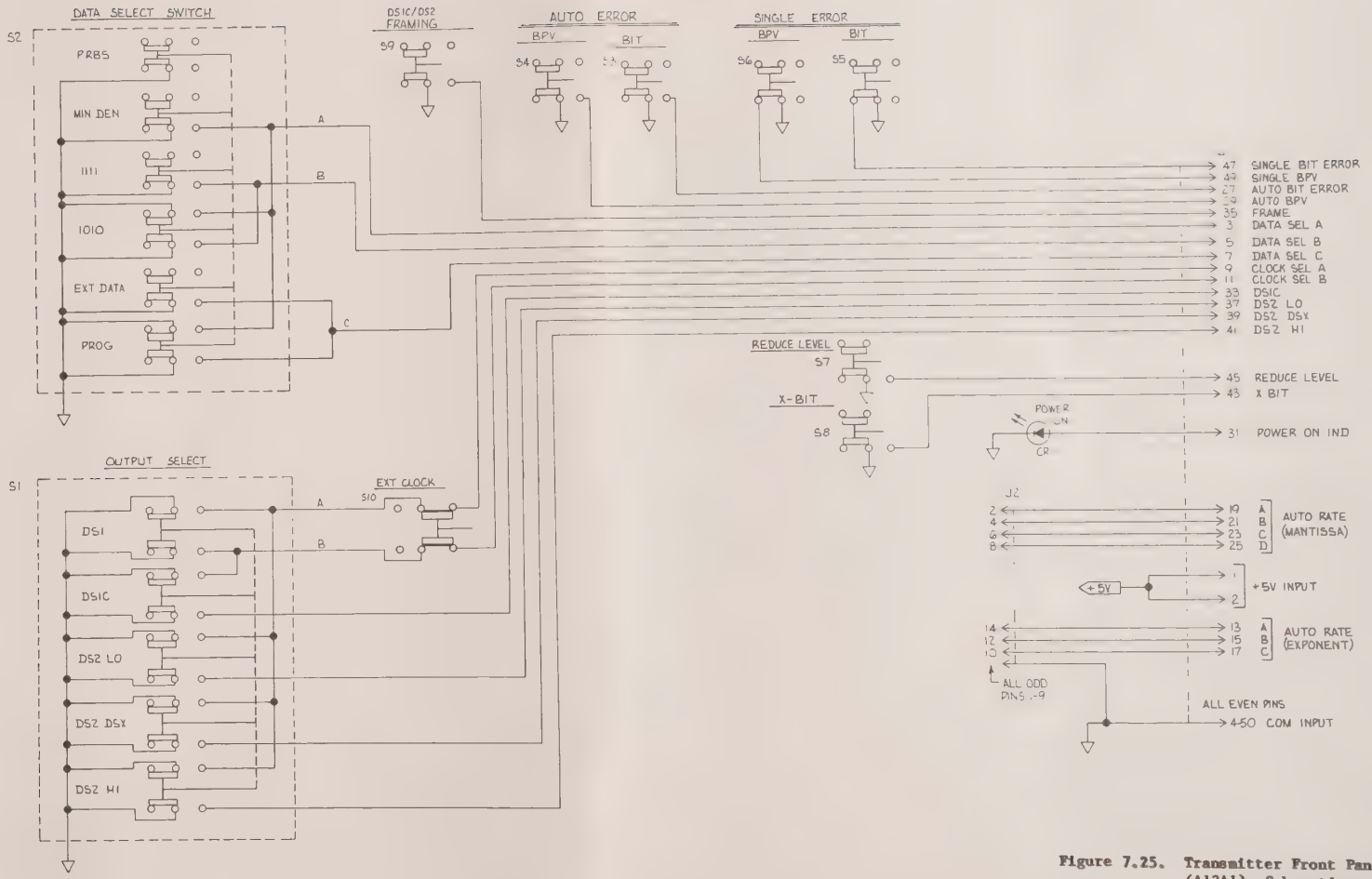


Figure 7.25. Transmitter Front Panel Assembly (A12A1), Schematic

252720B
35G037Z

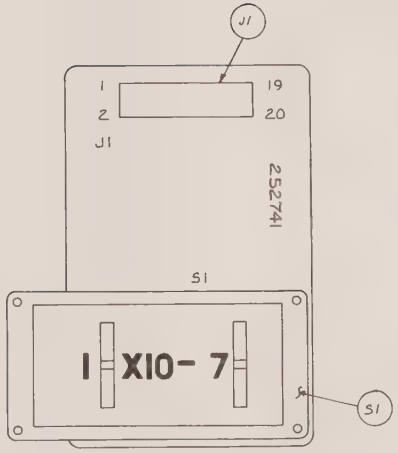


Figure 7.26. Transmitter Flex Circuit Auto Rate Switch Assembly (A12A2), Component Location

252741
35G037Z

S1

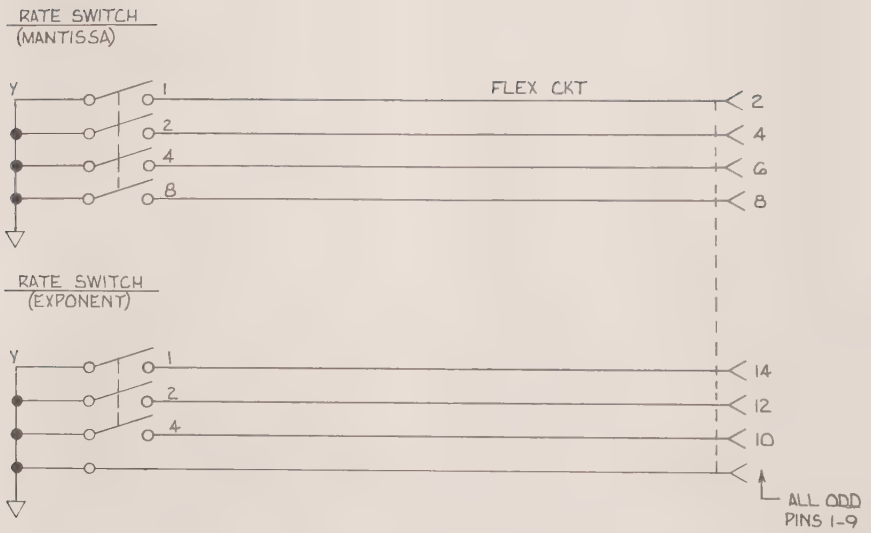


Figure 7.27. Transmitter Flex Circuit Auto Rate Switch Assembly (A12A2), Schematic

252739

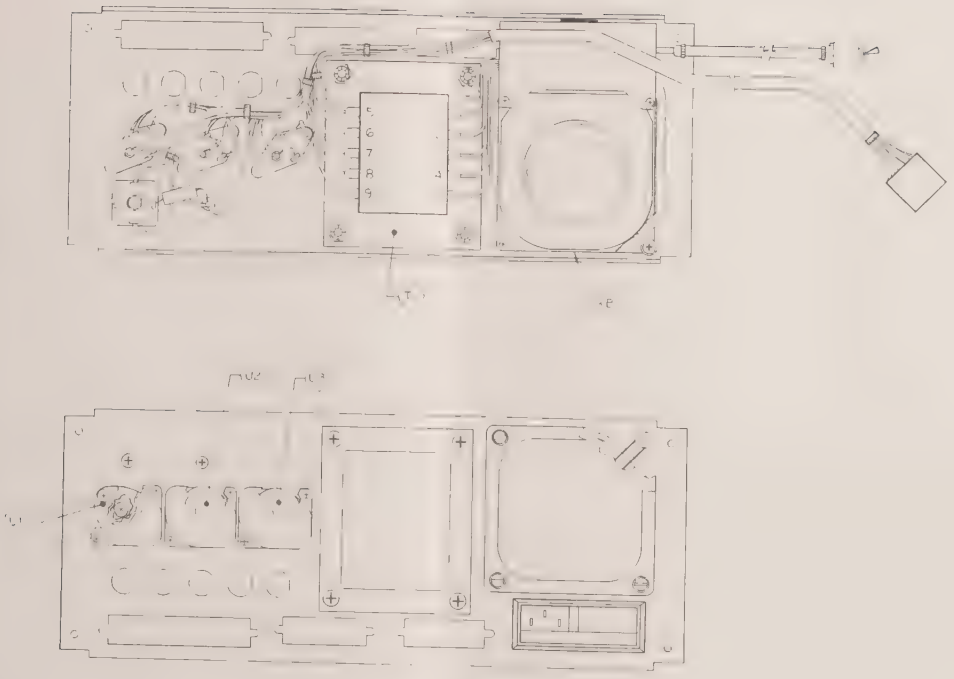


Figure 7.28. Transmitter Rear Panel Assembly (A13) (AC Version Only), Component Location/Cable Installation Reference

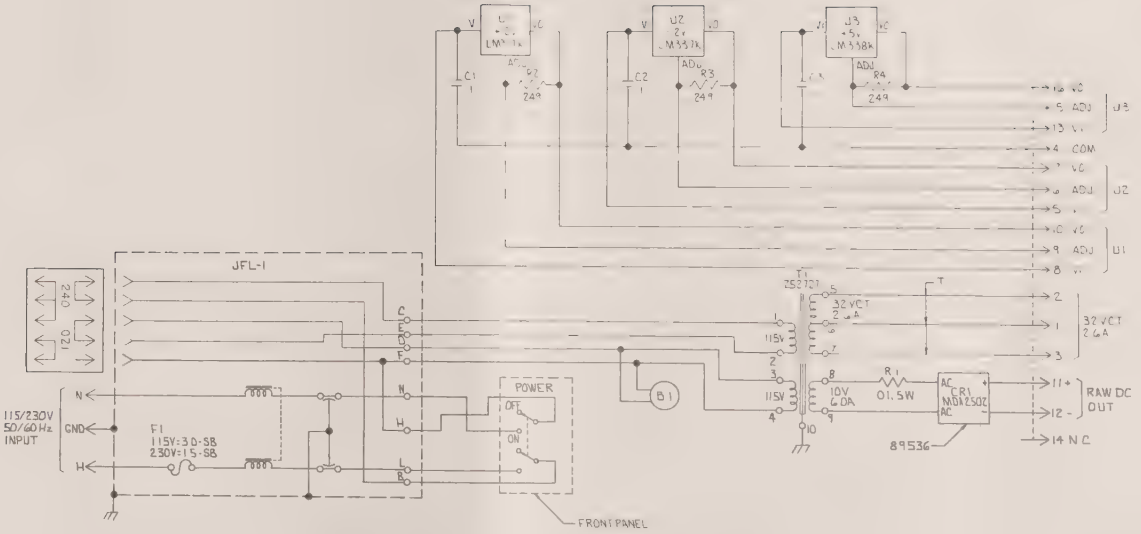


Figure 7.29. Transmitter Rear Panel Assembly (A13) (AC Version Only), Schematic

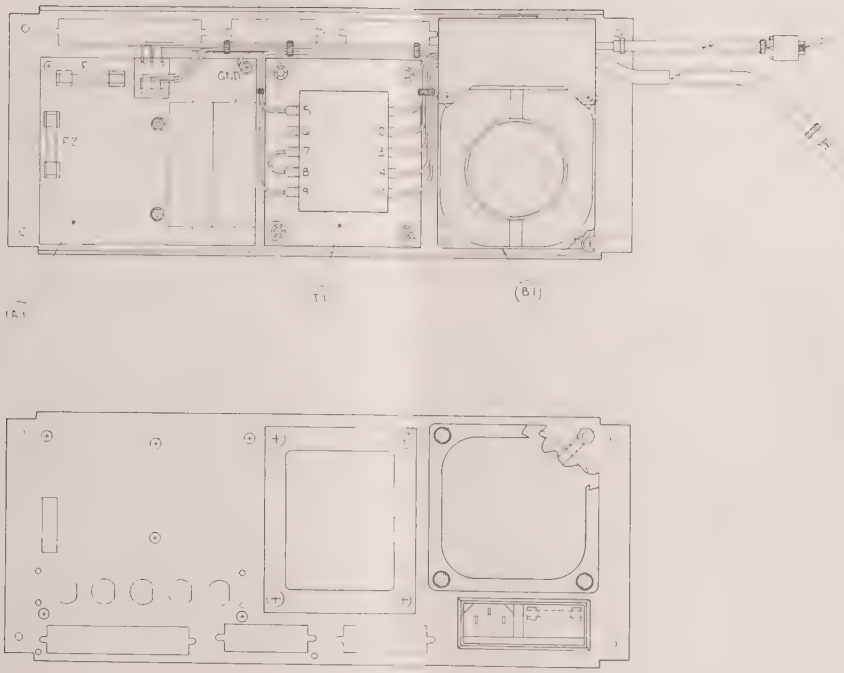
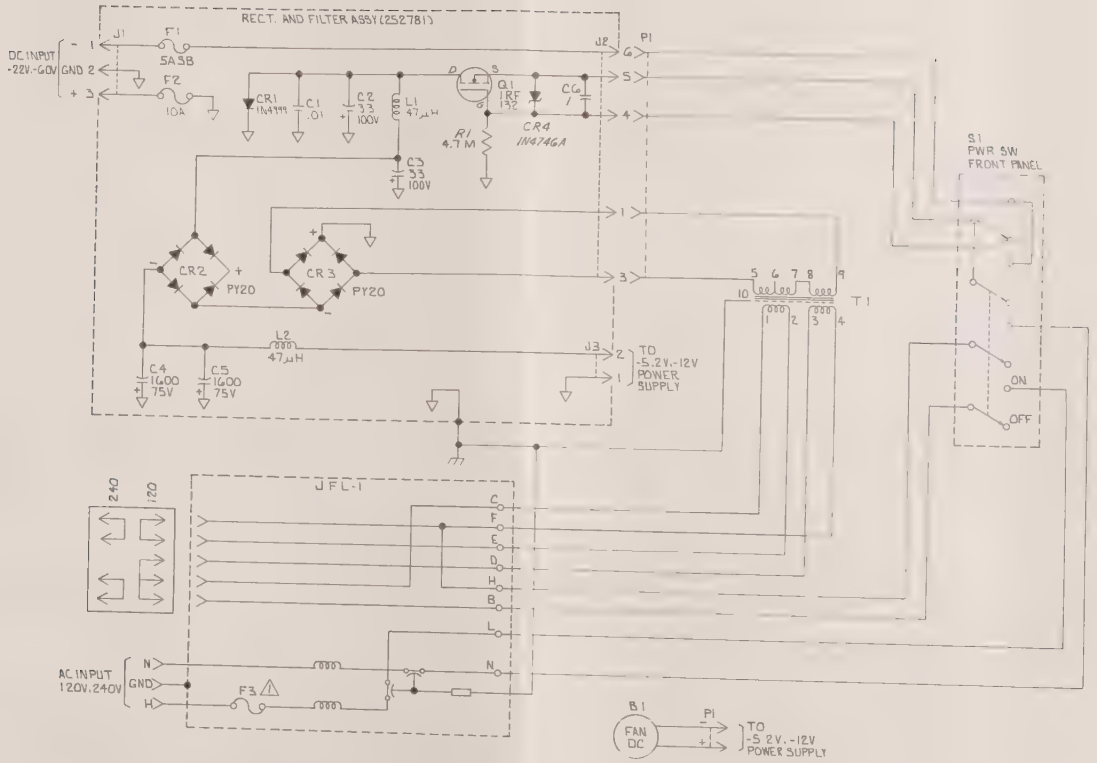


Figure 7.30. Transmitter Rear Panel Assembly (A13) (AC/DC Version Only), Component Location/Cable Installation Reference



NOTES

⚠ FUSE CHART

MODE	F3	
	120 VAC	240 VAC
4653	½ ASB	¼ ASB
4654	1½ ASB	¾ ASB
4656	1 ASB	½ ASB
4651A	1 ASB	½ ASB
4652A	2½ ASB	1¼ ASB

Figure 7.31. Transmitter Rear Panel Assembly (A13) (AC/DC Version Only), Schematic

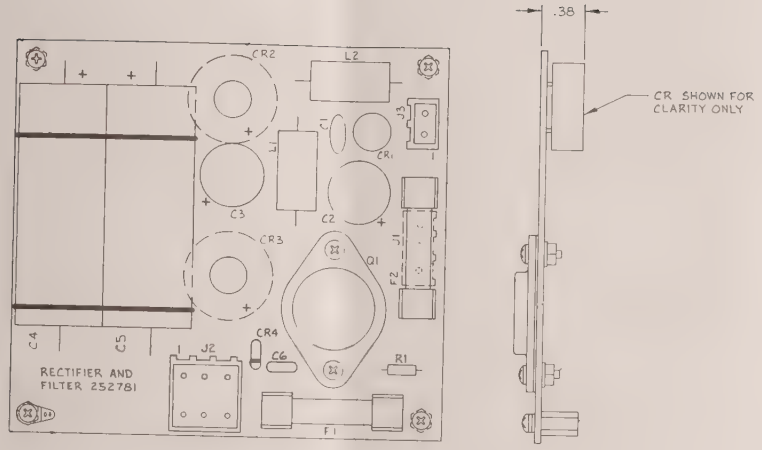
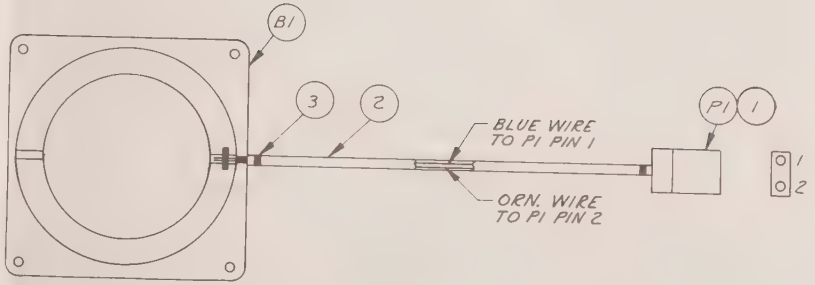


Figure 7.32. Transmitter Rectifier and Filter Assembly (A13A1) (AC/DC Version Only), Component Location

252781D
35G037Z



ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO	CODE IDENT
B1	1	89647	FAN	9.5-14 VDC		
P1	1	87358	CONN. HOUSING, RECT.	2 CKT., BLUE	1-480-720-6	
3	2	73045	CABLE TIE	4 IN. LONG		
2	.9FT	73212	TUBING, VINYL	8 AWG.		
1	2	86010	CONN. CONTACT, FEM.		60617-5	

Figure 7.33. Transmitter Rear Panel Fan Assembly (A13B1) (AC/DC Version Only)

220951

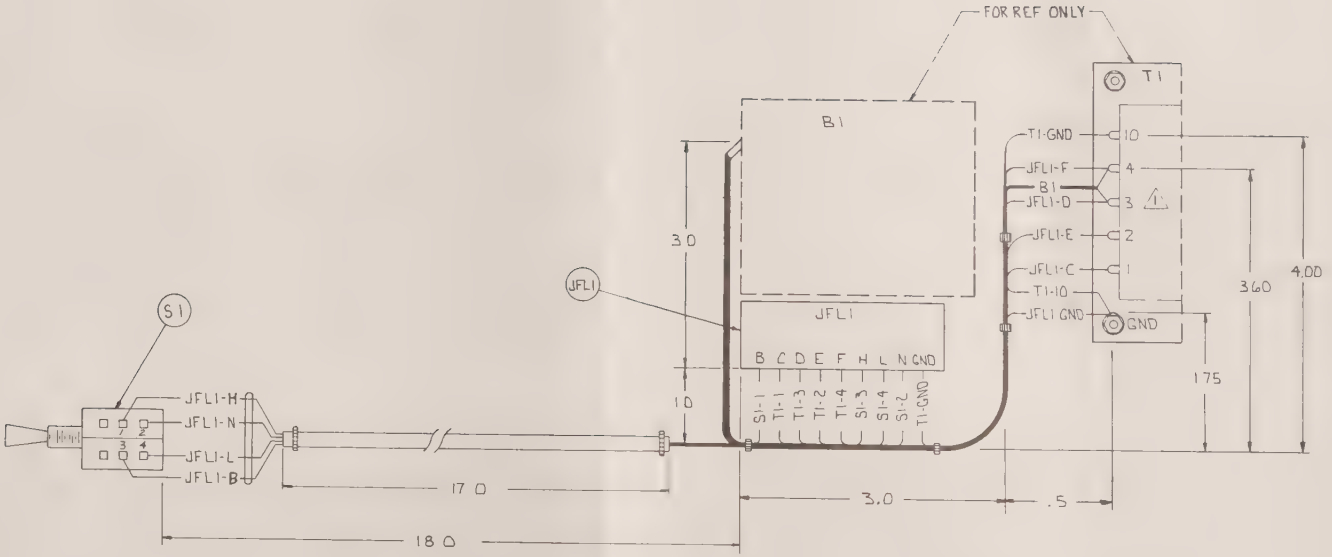
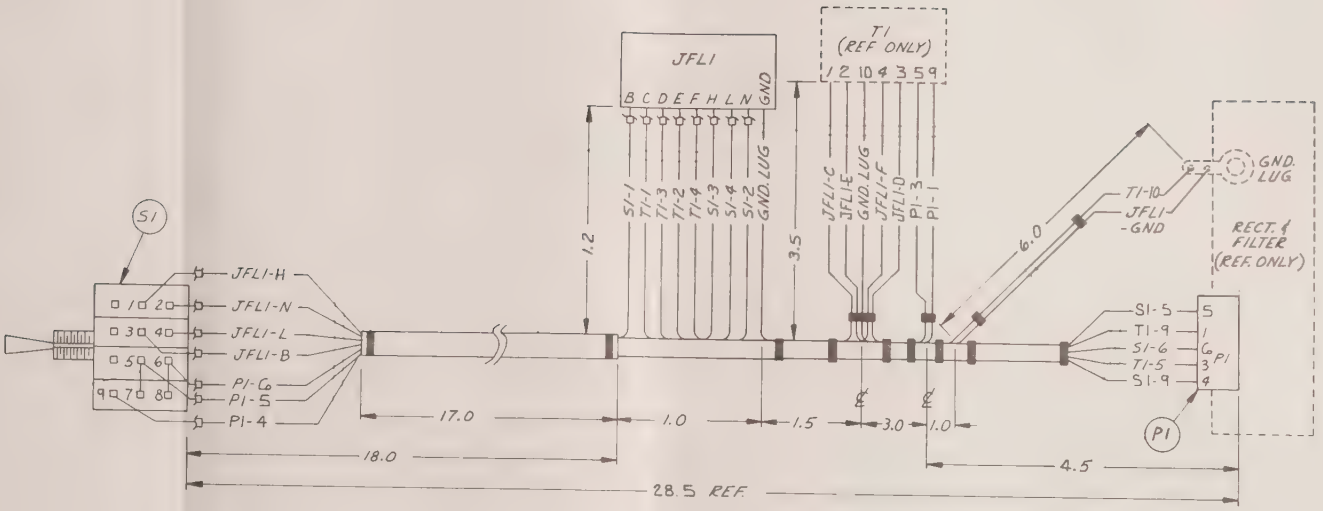


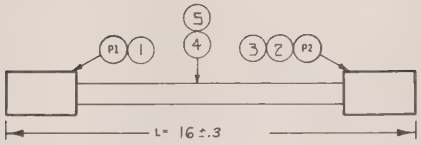
Figure 7.34. Transmitter Power Wiring Harness (AC Version Only)

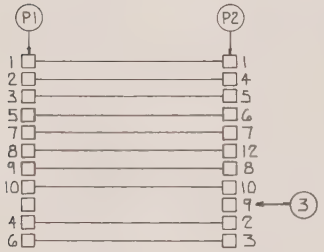
252744A
35G037Z



JFLI	1	83759	CONN., AC, 3 COND.	MALE W/FUSE BLK & FILT.	6J4
P1	1	82767	CONN. HOUSING, RECT.	POS. LOCK, 9 CKT.	1-480722-0
S1	1	170261	SWITCH, 4PDT		
7	.2FT	73318	WIRE, BUS	22 AWG	
6	.1FT	75929	TUBING, HEAT SHRINK	.125 ID	
5	14FT	73208	TUBING, VINYL	9 AWG	
4	5	86010	CONN. CONTACT, FEM.		60617-5
3	13	73045	CABLE TIE	4 IN. LONG	
2	7FT	73356	WIRE, STR'D., WHT.	18 AWG	
1	147FT	73374	WIRE, STR'D., WHT.	20 AWG	
ITEM OR FIND NO.	QTY REQD	S A STOCK #	W MFR'S PART NO OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO.

Figure 7.35. Transmitter Power Wiring Harness (AC/DC Version Only)

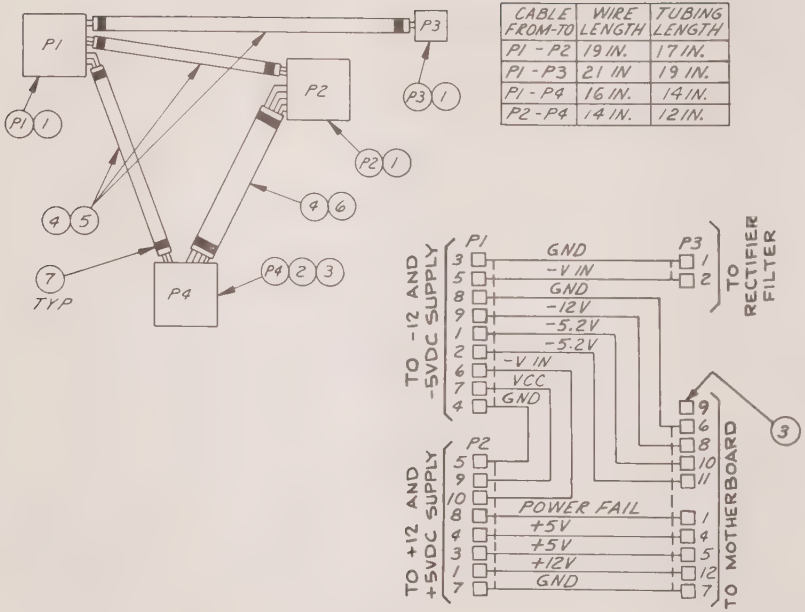




ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
5	1.3FT	73207	TUBING, VINYL	2 AWG	
4	14FT	73356	WIRE, STRD, WHT	18 AWG	
3	1	87429	PLUG, KEYING		87116-2
2	10	89565	CONN. CONTACT, FEM	18-22 AWG	87027-3
1	10	86010	CONN. CONTACT, FEM	18-22 AWG	60617-5
P2	1	89674	CONN HOUSING RECT	12 CKT	1-87025-1
P1	1	87046	CONN HOUSING, RECT	FREE HANGING, 10 CKT	1-480285-0

Figure 7.36. Transmitter Power Wiring Harness (AC Version Only)

252751
35G037Z



ITEM OR FIND NO	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
P4	1	89674	CONN. HOUSING, RECT.	12 CKT.	1-87025-1
P3	1	87352	CONN. HOUSING, RECT.	POS. LOCK, 2 CKT.	1-480720-0
P2	1	170256	CONN. HOUSING, RECT.	FREE HNG., 10 CKT.	1-480285-2
P1	1	87046	CONN. HOUSING, RECT.	FREE HNG., 10 CKT.	1-480285-0
7	8	73045	CABLE TIES	4 IN. LONG	
6	.8FT	73207	TUBING, VINYL	2 AWG	
5	3.5FT	73212	TUBING, VINYL	8 AWG	
4	14.7FT	73356	WIRE, STRD., WHT.	18 AWG	
3	1	87429	KEY		87116-2
2	9	89565	CONN. CONTACT, FEM.		87027-3
1	19	86010	CONN. CONTACT, FEM.		60617-5

Figure 7.37. Transmitter Power Wiring Harness (AC/DC Version Only)

220947A

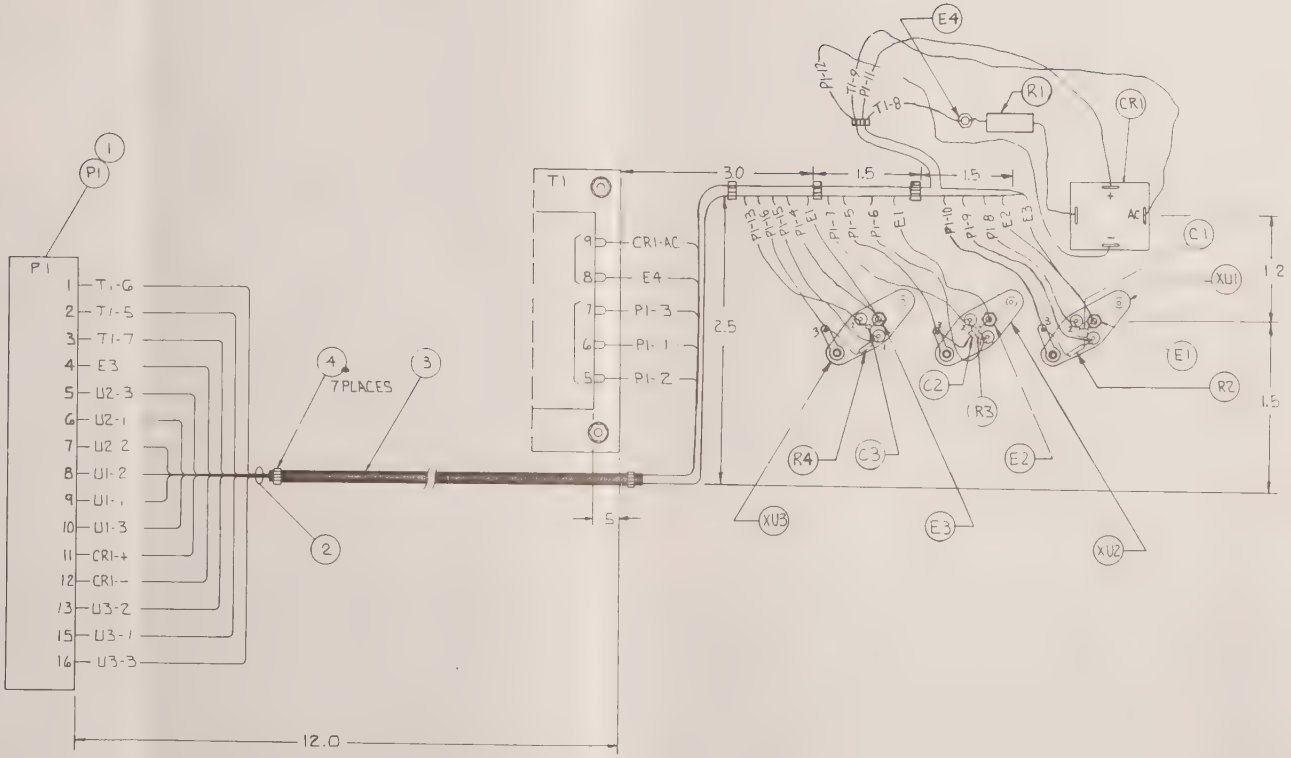
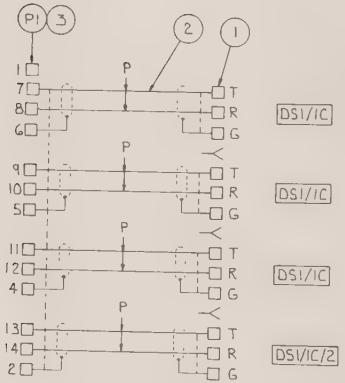
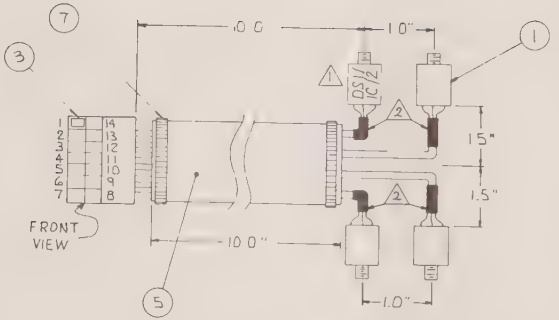


Figure 7.38. Transmitter Power Regulator Wiring Harness (AC Version Only)

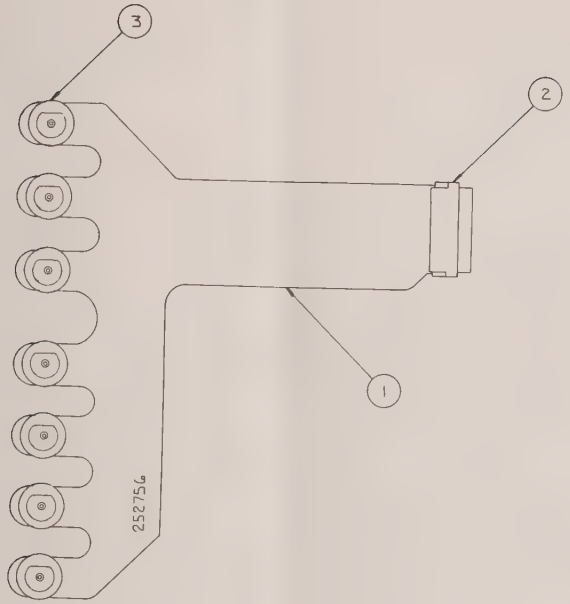


BOTTOM VIEW
ITEM 1
PHONE JACK



ITEM OR FIND NO	QTY REQD	X X STOCK NO	DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
7	2	73045	CABLE TIE	4 INCHES	
6	.35FT	77936	TUBING, HEATSHRINK	.187 ID	FIT-221-3/16 BLK
5	.85FT	75931	TUBING, VINYL	.313 ID	TEMFLEX 105 BLK
					86286-1
3	13	88380	CONN CONTACT	AWG 20-24	1-87309-4
2	45FT	70380	CABLE, 2CNDCT, SHIELDED	AWG 22,24 AWG SHLD	8451
1	4	86781	J, PHONE, 3CNDCT, 3CONTACT		M1128
P1	1	89553	CONN CABLE HOUSING	14 PIN	1-87631-0

Figure 7-39. Transmitter DS1/1C/2 Output Cable Assembly (W1)



ITEM OR FIND NO.	QTY REQD	S A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE	IDENTIFYING OR PART NO
3	1	171521	CONN BNC FEM-PC		KC-79-238-M06
2	1	170210	CONN. FEM FLAT CABLE	12 PIN	
1	1	252755	FLEX CKT		

Figure 7-40. Transmitter Flex Circuit Cable Assembly (W2)

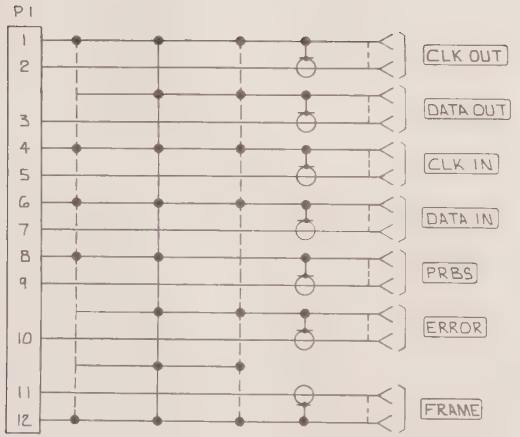
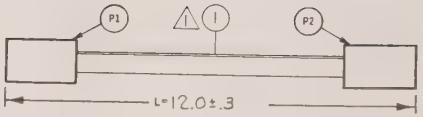
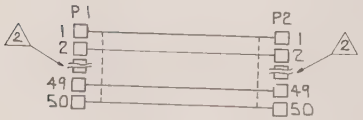


Figure 7-41. Transmitter Flex Circuit Cable Assembly (W2), Schematic





NOTES

1. RED LINE DENOTES PIN 1.
2. PINS ON P1 CONNECTED TO IDENTICAL PINS ON P2

TERMINAL FINDING	QTY REQD	S-A STOCK NO	NOMENCLATURE OR DESCRIPTION	MATL SPEC AND SIZE OR COMPONENT VALUE
P2	1	84379	CONN. FLAT. 50 PIN	FEM
P1	1	84379	CONN. FLAT. 50 PIN	FEM.
1	1.1 FT	84305	CABLE, FLAT. 50 COND	28 AWG

Figure 7-42. Transmitter Front Panel I/O Cable Assembly (W3)

CONVERSION OF VOLTAGE AND POWER RATIOS TO DECIBELS

The basic chart below indicates the number of decibels (dB) corresponding to the listed ratios of voltage or power over the range of −20 to +20 dB. For voltage or power ratios greater than those included in the chart, the ratio can be broken down into a product of two numbers, the value in dB for each found separately, and the two results added. Example: To convert a power ratio of 2,000:1 to dB, express 2,000 as 2×10^3; the number of dB corresponding to a power ratio of 2 is very nearly 3, and the number of dB for a power ratio of 10^3 is 30. Therefore, the power ratio of 2,000:1 is approximately 30 dB + 3 dB = 33 dB. In the lower righthand corner of the chart dB values for voltage and power ratios of integral powers of 10 are given.

Voltage Ratio	*Power Ratio*	*−dB +*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB +*	*Voltage Ratio*	*Power Ratio*	*Voltage Ratio*	*Power Ratio*	*−dB +*	*Voltage Ratio*	*Power Ratio*
1.000	**1.000**	**0**	**1.000**	**1.000**	**.447**	**.200**	**7.0**	**2.239**	**5.012**	**.200**	**.0398**	**14.0**	**5.012**	**25.12**
.989	.977	.1	1.012	1.023	.442	.195	7.1	2.265	5.129	.197	.0389	14.1	5.070	25.70
.977	.955	.2	1.023	1.047	.437	.191	7.2	2.291	5.248	.195	.0380	14.2	5.129	26.30
.966	.933	.3	1.035	1.072	.432	.186	7.3	2.317	5.370	.193	.0372	14.3	5.188	26.92
.955	.912	.4	1.047	1.096	.427	.182	7.4	2.344	5.495	.191	.0363	14.4	5.248	27.54
.944	.891	.5	1.059	1.122	.422	.178	7.5	2.371	5.623	.188	.0355	14.5	5.309	28.18
.933	.871	.6	1.072	1.148	.417	.174	7.6	2.399	5.754	.186	.0347	14.6	5.370	28.84
.923	.851	.7	1.084	1.175	.412	.170	7.7	2.427	5.888	.184	.0339	14.7	5.433	29.51
.912	.832	.8	1.096	1.202	.407	.166	7.8	2.455	6.026	.182	.0331	14.8	5.495	30.20
.902	.813	.9	1.109	1.230	.403	.162	7.9	2.483	6.166	.180	.0324	14.9	5.559	30.90
.891	**.794**	**1.0**	**1.122**	**1.259**	**.398**	**.159**	**8.0**	**2.512**	**6.310**	**.178**	**.0316**	**15.0**	**5.623**	**31.62**
.881	.776	1.1	1.135	1.288	.394	.155	8.1	2.541	6.457	.176	.0309	15.1	5.689	32.36
.871	.759	1.2	1.148	1.318	.389	.151	8.2	2.570	6.607	.174	.0302	15.2	5.754	33.11
.861	.741	1.3	1.161	1.349	.385	.148	8.3	2.600	6.761	.172	.0295	15.3	5.821	33.88
.851	.724	1.4	1.175	1.380	.380	.145	8.4	2.630	6.918	.170	.0288	15.4	5.888	34.67
.841	.708	1.5	1.189	1.413	.376	.141	8.5	2.661	7.079	.168	.0282	15.5	5.957	35.48
.832	.692	1.6	1.202	1.445	.372	.138	8.6	2.692	7.244	.166	.0275	15.6	6.026	36.31
.822	.676	1.7	1.216	1.479	.367	.135	8.7	2.723	7.413	.164	.0269	15.7	6.095	37.15
.813	.661	1.8	1.230	1.514	.363	.132	8.8	2.754	7.586	.162	.0263	15.8	6.166	38.02
.804	.646	1.9	1.245	1.549	.359	.129	8.9	2.786	7.762	.160	.0257	15.9	6.237	38.90
.794	**.631**	**2.0**	**1.259**	**1.585**	**.355**	**.126**	**9.0**	**2.818**	**7.943**	**.159**	**.0251**	**16.0**	**6.310**	**39.81**
.785	.617	2.1	1.274	1.622	.351	.123	9.1	2.851	8.128	.157	.0246	16.1	6.383	40.74
.776	.603	2.2	1.288	1.660	.347	.120	9.2	2.884	8.318	.155	.0240	16.2	6.457	41.69
.767	.589	2.3	1.303	1.698	.343	.118	9.3	2.917	8.511	.153	.0234	16.3	6.531	42.66
.759	.575	2.4	1.318	1.738	.339	.115	9.4	2.951	8.710	.151	.0229	16.4	6.607	43.65
.750	.562	2.5	1.334	1.778	.335	.112	9.5	2.985	8.913	.150	.0224	16.5	6.683	44.67
.741	.550	2.6	1.349	1.820	.331	.110	9.6	3.020	9.120	.148	.0219	16.6	6.761	45.71
.733	.537	2.7	1.365	1.862	.327	.107	9.7	3.055	9.333	.146	.0214	16.7	6.839	46.77
.724	.525	2.8	1.380	1.905	.324	.105	9.8	3.090	9.550	.145	.0209	16.8	6.918	47.86
.716	.513	2.9	1.396	1.950	.320	.102	9.9	3.126	9.772	.143	.0204	16.9	6.998	48.98
.708	**.501**	**3.0**	**1.413**	**1.995**	**.316**	**.100**	**10.0**	**3.162**	**10.000**	**.141**	**.0200**	**17.0**	**7.079**	**50.12**
.700	.490	3.1	1.429	2.042	.313	.0977	10.1	3.199	10.23	.140	.0195	17.1	7.161	51.29
.692	.479	3.2	1.445	2.089	.309	.0955	10.2	3.236	10.47	.138	.0191	17.2	7.244	52.48
.684	.468	3.3	1.462	2.138	.306	.0933	10.3	3.273	10.72	.137	.0186	17.3	7.328	53.70
.676	.457	3.4	1.479	2.188	.302	.0912	10.4	3.311	10.96	.135	.0182	17.4	7.413	54.95
.668	.447	3.5	1.496	2.239	.299	.0891	10.5	3.350	11.22	.133	.0178	17.5	7.499	56.23
.661	.437	3.6	1.514	2.291	.295	.0871	10.6	3.388	11.48	.132	.0174	17.6	7.586	57.54
.653	.427	3.7	1.531	2.344	.292	.0851	10.7	3.428	11.75	.130	.0170	17.7	7.674	58.88
.646	.417	3.8	1.549	2.399	.288	.0832	10.8	3.467	12.02	.129	.0166	17.8	7.762	60.26
.638	.407	3.9	1.567	2.455	.285	.0813	10.9	3.508	12.30	.127	.0162	17.9	7.852	61.66
.631	**.398**	**4.0**	**1.585**	**2.512**	**.282**	**.0794**	**11.0**	**3.548**	**12.59**	**.126**	**.0159**	**18.0**	**7.943**	**63.10**
.624	.389	4.1	1.603	2.570	.279	.0776	11.1	3.589	12.88	.125	.0155	18.1	8.035	64.57
.617	.380	4.2	1.622	2.630	.275	.0759	11.2	3.631	13.18	.123	.0151	18.2	8.128	66.07
.610	.372	4.3	1.641	2.692	.272	.0741	11.3	3.673	13.49	.122	.0148	18.3	8.222	67.61
.603	.363	4.4	1.660	2.754	.269	.0724	11.4	3.715	13.80	.120	.0145	18.4	8.318	69.18
.596	.355	4.5	1.679	2.818	.266	.0708	11.5	3.758	14.13	.119	.0141	18.5	8.414	70.79
.589	.347	4.6	1.698	2.884	.263	.0692	11.6	3.802	14.45	.118	.0138	18.6	8.511	72.44
.582	.339	4.7	1.718	2.951	.260	.0676	11.7	3.846	14.79	.116	.0135	18.7	8.610	74.13
.575	.331	4.8	1.738	3.020	.257	.0661	11.8	3.890	15.14	.115	.0132	18.8	8.710	75.86
.569	.324	4.9	1.758	3.090	.254	.0646	11.9	3.936	15.49	.114	.0129	18.9	8.811	77.62
.562	**.316**	**5.0**	**1.778**	**3.162**	**.251**	**.0631**	**12.0**	**3.981**	**15.85**	**.112**	**.0126**	**19.0**	**8.913**	**79.43**
.556	.309	5.1	1.799	3.236	.248	.0617	12.1	4.027	16.22	.111	.0123	19.1	9.016	81.28
.550	.302	5.2	1.820	3.311	.246	.0603	12.2	4.074	16.60	.110	.0120	19.2	9.120	83.18
.543	.295	5.3	1.841	3.388	.243	.0589	12.3	4.121	16.98	.108	.0118	19.3	9.226	85.11
.537	.288	5.4	1.862	3.467	.240	.0575	12.4	4.169	17.38	.107	.0115	19.4	9.333	87.10
.531	.282	5.5	1.884	3.548	.237	.0562	12.5	4.217	17.78	.106	.0112	19.5	9.441	89.13
.525	.275	5.6	1.905	3.631	.234	.0550	12.6	4.266	18.20	.105	.0110	19.6	9.550	91.20
.519	.269	5.7	1.928	3.715	.232	.0537	12.7	4.315	18.62	.104	.0107	19.7	9.661	93.33
.513	.263	5.8	1.950	3.802	.229	.0525	12.8	4.365	19.05	.102	.0105	19.8	9.772	95.50
.507	.257	5.9	1.972	3.890	.227	.0513	12.9	4.416	19.50	.101	.0102	19.9	9.886	97.72
.501	**.251**	**6.0**	**1.995**	**3.981**	**.224**	**.0501**	**13.0**	**4.467**	**19.95**	**.100**	**.0100**	**20.0**	**10.000**	**100.00**
.496	.246	6.1	2.018	4.074	.221	.0490	13.1	4.519	20.42					
.490	.240	6.2	2.042	4.169	.219	.0479	13.2	4.571	20.89		10^{-3}	30		10^3
.484	.234	6.3	2.065	4.266	.216	.0468	13.3	4.624	21.38	10^{-2}	10^{-4}	40	10^2	10^4
.479	.229	6.4	2.089	4.365	.214	.0457	13.4	4.677	21.88					
											10^{-5}	50		10^5
.473	.224	6.5	2.113	4.467	.211	.0447	13.5	4.732	22.39	10^{-3}	10^{-6}	60	10^3	10^6
.468	.219	6.6	2.138	4.571	.209	.0437	13.6	4.786	22.91		10^{-7}	70		10^7
.462	.214	6.7	2.163	4.677	.207	.0427	13.7	4.842	23.44	10^{-4}	10^{-8}	80	10^4	10^8
.457	.209	6.8	2.188	4.786	.204	.0417	13.8	4.898	23.99		10^{-9}	90		10^9
.452	.204	6.9	2.213	4.898	.202	.0407	13.9	4.955	24.55					
										10^{-5}	10^{-10}	100	10^5	10^{10}
											10^{-11}	110		10^{11}
										10^{-6}	10^{-12}	120	10^6	10^{12}

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